PHILIPS VALVE HANDBOOK

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THE ELECTRONIC VALVE

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Electronic valves have held an important position in electro-technical engineering for many years, but World War II opened up many more new fields of application for the high-vacuum and gas-filled valves. In addition to introducing considerable improvements in telecommunications, radar, navigation and radio broadcasting, these valves have become essential in modern production processes throughout an ever-increasing variety of industries.

Knowledge of these valves and their applications is therefore no longer limited to engineers and technicians in radio and telecommunications, but is rapidly becoming essential for those engaged in other industries.

To develop a wider knowledge of the properties and applications of electronic valves, Philips Technical Library are publishing a comprehensive series of books, many of which are available now. The series will be extended to keep pace with developments.

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BOOK 1: "Fundamentals of Radio Valve Technique"
547 pages, 6in. x 9in., 384 illustrations.

This up-to-date work deals with physical principles, latest constructions and properties of radio receiving and amplifying valves. A special chapter has been devoted to the mathematics of valve characteristics.

Clearly and concisely written, this book will appeal to all who are concerned with the design, manufacture or repair of radio and electronic apparatus. Furthermore, because of its exceptional clarity, this is an excellent text-book for the student.

PRICE £1/6/0 post free.

BOOK 2: "Data and Circuits of Receiving and Amplifying Valves"
427 pages, 6in. x 9in., 532 illustrations.

Books 2, 3 and 3A survey all receiving and amplifying valves produced by Philips since 1933. Book 2 contains data on valves placed on the market between 1933 and 1939. Extensive tables, characteristics and circuit diagrams are included.

PRICE 16/- post free.


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Tropic of Capricorn

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Vaasa
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N Dvina
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Ivanovo
Gorki
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Taurus
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Athens
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Hama
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20 0 20 40 60 80 100 120 Kilometres
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Canals
2764 Heights in feet
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Whalsay
Lerwick
Bressay
Mainland
Papa Stour
Foula
Sumburgh Hd.
Fair I.
N. Ronaldsay
Sanday
Orkney Is.
Westray
Rousay
Stronsay
Shapinsay
Kirkwall
Hoy
S. Ronaldshay
Pentland Firth
Duncansby Hd.
John o'Groats
Wick
Thurso
Dunnett Hd.
C. Wrath
L. Eriboll
Ben Hope
Ben More
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Dornoch Firth
Moray Firth
Lossiemouth
Banff
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Buchan Ness
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Elgin
Forres
Nairn
Cromarty
Inverness
Huntly
Inverurie
Aberdeen
Stonehaven
Ballater
Balmoral
Dee
Montrose
Forfar
Arbroath
Firth of Tay
Dundee
St Andrews
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Anstruther
Firth of Forth
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South Shields
Sunderland
W. Hartlepool
Newcastle
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Cheviot Hills
Tweed
Galashiels
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Carlisle
Nith
Kirkcudbright
Newton Stewart
Wigtown
Stranraer
Merrick 2764
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Prestwick
Kilmarnock
Irvine
Lanark
Hamilton
Motherwell
GLASGOW
Falkirk
Stirling
Paisley
Greenock
Dumbarton
L. Lomond
Crieff
Perth
Cupar
Kinross
Dunfermline
Alloa
L. Tay
L. Rannoch
Blairgowrie
Tay
SCOTLAND
Grampian Mts.
Glen More
Ben Nevis 4406
Ft. William
L. Lochy
Kingussie
L. Ness
Beauly
Dingwall
Tain
Dornoch
Lairg
Ben Wyvis 3429
Ullapool
L. Broom
L. Maree
L. Torridon
Kyle of Lochalsh
Mam Soul
Mallaig
L. Linnhe
Oban
L. Awe
L. Fyne
Rothesay
Arran
Firth of Clyde
Kintyre
Campbeltown
Jura
Sd. of Jura
Islay
Colonsay
F. of Lorne
Mull
Iona
Tobermory
Tiree
Coll
Ardnamurchan Pt.
Eigg
Rhum
Cuillin Sd.
Skye
Portree
The Minch
Lewis
Stornoway
Butt of Lewis
L. Roag
Sound of Harris
Harris
North Uist
Benbecula
South Uist
Barra
Outer Hebrides
Inner Hebrides
North Channel
Fair Hd.
Rathlin I.
Giant's Causeway
Portrush
Coleraine
Antrim Mts.
Ballymena
Larne
Bann
Londonderry
L. Foyle
Moville
Malin Hd.
Strabane
Foyle
L. Swilly
Tory I.
Bloody Foreland
Aran I.
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Rybachi Pen.
Varanger Fd.
Varanger Pen.
Tana Fd.
Nordkinn
North C.
Porsanger Fd.
Finnmark
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Söröya
Lopp Havet
Tromsö
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Kebnekaise 6965
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Vesterålen
Lofoten Is.
Vest Fjord
Bodo
Mo
Namsen
Namsos
Trondheim
Kristiansund
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Boden
Gällivare
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Tornio
Kemi
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Vaasa
Kokkola
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Inari
L. Inari
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Akureyri
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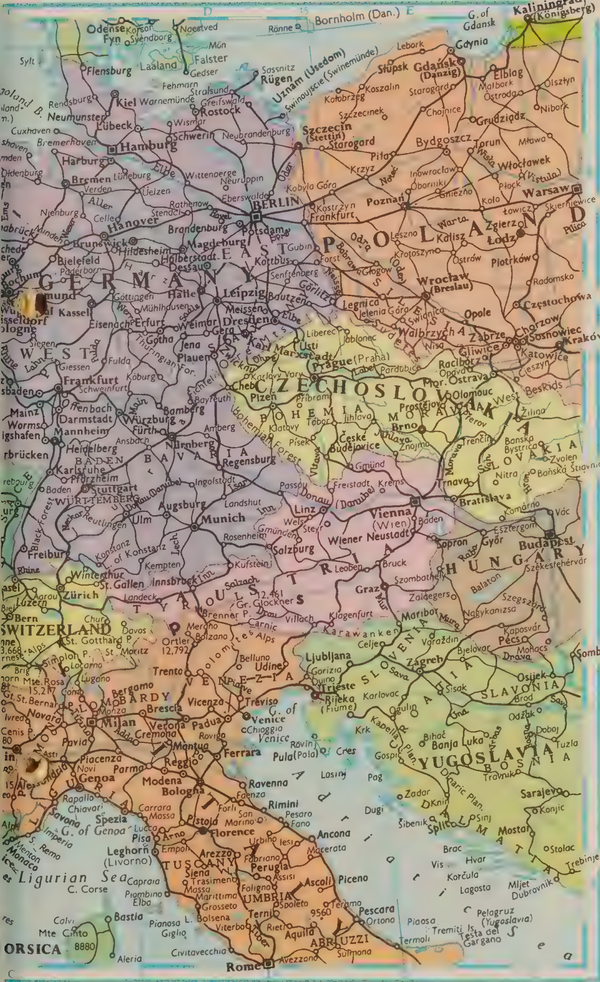
D
E
Bornholm (Dan.)
Rönne
G. of Gdansk
Kaliningrad (Königsberg)
Odense
Fyn
Korsör
Svendborg
Naestved
Mön
Falster
Gedser
Laaland
Sylt
Flensburg
Fehmarn
Kiel
Warnemünde
Stralsund
Greifswald
Rostock
Rügen
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Swinoujscie (Swinemünde)
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Verden
Uelzen
Elbe
Wittenberge
Neuruppin
Eberswalde
Aller
Nienburg
Celle
Stendal
Rathenow
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Potsdam
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Halberstadt
Dessau
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Innsbruck
TYROL
St. Gotthard P.
St. Moritz
Simplon P.
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Lugano
Brig
Mte. Rosa 15,217
Gt. St. Bernard
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Ortler 12,792
Merano
Bolzano
Brenner P.
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Trento
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Pavia
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Mantua
Rovigo
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Asti
Alessandria
Rapallo
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Carrara
Massa
Savona
G. of Genoa
Imperia
S. Remo
Menton
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Ligurian Sea
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Arno
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L. Trasimeno
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Rimini
Pesaro
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Macerata
Ascoli Piceno
Teramo
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Aquila
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Avezzano
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Tremiti Is.
Testa del Gargano
Pelagruz (Yugoslavia)
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Udine
VENEZIA
Piave
Treviso
Venice
Chioggia
G. of Venice
Gorizia
Trieste
Rijeka (Fiume)
Pula (Pola)
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Losinj
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Pag
Zadar
Dugi
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Sinj
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Brac
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Dubrovnik
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Stolac
Mostar
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DALMATIA
Dinaric Plan.
YUGOSLAVIA
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Banja Luka
Doboj
Tuzla
Odžak
Brod
Sava
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Osijek
Sombor
Drava
Mohacs
Pecs
Kaposvár
Nagykanizsa
Varaždin
Zagreb
Sisak
Karlovac
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Kapella Plan.
Gospic
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SLOVENIA
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Drau
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Salzach
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Přerov
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MORAVIA
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Gmünd
České Budějovice
Tábor
Písek
Vltava
Klatovy
Bohemian Forest
BOHEMIA
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Zgierz
Łódź
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Wisła
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Inowrocław
Oborniki
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Krzyż
Piła
Kobyla Góra
Szczecin (Stettin)
Stargard
Szczecinek
Koszalin
Kołobrzeg
Słupsk
Lebork
Gdynia
Gdańsk (Danzig)
Starogard
Chojnice
Grudziądz
Elbląg
Malbork
Ostróda
Olsztyn
Nibork
Mława
Adriatic Sea


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Heights
YUGOSLAVIA
ALBANIA
FRANCE
ITALY
SPAIN
PORTUGAL
MOROCCO
ALGERIA
TUNISIA
LIBYA
ADRIATIC SEA
TYRRHENIAN SEA
Ionian Sea
MEDITERRANEAN SEA
Ligurian Sea
G. of Lions
Corsica
Sardinia
Sicily
Balearic Is
Minorca
Majorca
Ibiza
MALTA
Madrid
Rome
Barcelona
Valencia
Marseilles
Naples
Algiers
Tunis
Tripoli
Lisbon


EAST MEDITERRANEAN AND MIDDLE EAST
Scale 1 : 27,500,000 (440 miles = 1 inch)
Statute Miles
Kilometres
Railways
Canals
18,604 Heights in feet
U S S R
BLACK SEA
CASPIAN SEA
MEDITERRANEAN SEA
RED SEA
Persian Gulf
G. of 'Oman
Aegean Sea
TURKEY
SYRIA
LEBANON
ISRAEL
JORDAN
IRAQ
IRAN (PERSIA)
AFGHANISTAN
SAUDI ARABIA
EGYPT (U.A.R.)
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GREECE
CYPRUS
KUWAIT
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TRUCIAL OMAN
MUSCAT AND OMAN
LIBYA
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Athens
Thessaloniki
Beirut
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Tehran
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Amman
Cairo
Alexandria
Mecca
Riyadh
Karachi
Tropic of Cancer
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Chelyuskin
OCEAN
Laptev Sea
Kotelny
New Siberian Is.
East Siberian Sea
Wrangel I.
Tiksi
Nizhne Kolymsk
Sredne Kolymsk
Kolyma
Verkhoyansk
Indigirka
Olenek
Bulun
Khatanga
Lena
Aldan
G. of Anadyr
Bering Sea
Aleutian Is.
Komandorskiye Is.
Gizhiga
Magadan
Kamchatka
Petropavlovsk-Kamchatskiy
R.
Okhotsk
Sea of Okhotsk
Ayan
S.
Yakutsk
Vilyuysk
Olekminsk
Lower Tunguska
Stony Tunguska
Kirensk
Angara
Yeniseysk
Krasnoyarsk
Kuril Is.
Sakhalin
Nikolayevsk
Komsomolsk
Sovetskaya Gavan
Amur
Blagoveshchensk
Khabarovsk
L. Baikal
Chita
Nerchinsk
Aigun
Nunkiang
Tsitsihar
Novokuznetsk
Irkutsk
Ulan Ude
Kyakhta
Biysk
Yenisey
Selenga
Kerulen
Lupin
Ulan Bator
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Kirin
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Yokohama
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Osaka
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Hiroshima
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Kyushu
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Turfan
Tientsin
Chefoo
Tsingtao
Yellow Sea
Nagasaki
Changyeh
Taiyuan
Tsinan
Hwang Ho
Chinkiang
Shanghai
Ningpo
Lop Nor
Koko Nor
Lanchow
Sian
Kaifeng
Nanking
Soochow
Hangchow
Wenchow (Yungkia)
East China Sea
REPUBLIC
CHINA
Yangtse-Kiang
Ichang
Wuhan
Ryukyu Is.
Bonin Is.
Volcano Is.
Tropic of Cancer
Mariana Is. (U.S. Trust Terr.)
PACIFIC
Ch'amdo
Chengtu
Chungking
Changsha
Siangtan
Nanchang
Foochow (Minhow)
Taipeh
Taiwan
Tainan
Lhasa
Tsangpo
Shigatse
Batang
Kweiyang
Kweilin
Amoy
Canton
Swatow
Hong Kong (Br.)
Guam (U.S.)
Sadiya
Myitkyina
Kunming
Si-Kiang
Macao (Port.)
Tsamkong
Pakhoi
Red R.
Lashio
NORTH
Hanoi
G. of Tongking
Hainan
Luzon
PHILIPPINES
Dacca
BURMA
Mandalay
Chittagong
Irrawaddy
Salween
Chiangmai
LAOS
VIETNAM
Hue
South China Sea
Manila
Yap
Caroline Is.
Pelew Is. (U.S. Trust Terr.)
Bay of Bengal
THAILAND (SIAM)
Moulmein
Rangoon
Bangkok
CAMBODIA
Phnom Penh
Phan Rang
SOUTH
Saigon-Cholon
Palawan
Iloilo
Cebu
Mindanao
Davao
Andaman Is.
G. of Siam
Spratley
Amboina
Sulu Sea
Zamboanga
Sabah (North Borneo)
Kota Kinabalu
Sandakan
Sulu Is.
Halmahera
Schouten Is.
Nicobar Is. (India)
MALAYSIA
MALAYA
Labuan
Brunei
Natuna Is.
Celebes Sea
Manado
Moluccas
Sukarnapura
W. Irian
New Guinea
Fakfak
Penang
Banda Atjeh
Str. of Malacca
Kuala Lumpur
Malacca
Kuching
Sarawak
Borneo
Sulawesi
Buru
Ceram
Aru Is.
Medan
Sumatra
Singapore
Pontianak
Banda Sea
Tanimbar Is.
Arafura Sea
Thursday I.
Padang
Bangka
Bandjermasin
Makasar
INDONESIA
Palembang
Djakarta
Java Sea
Flores
Timor (Port)
Darwin
Sunda Str.
Java
Surabaja
Semarang
Bali
Lombok
Sumbawa
Sumba
140


NORTH ATLANTIC OCEAN
MEDITERRANEAN SEA
Black Sea
Caspian Sea
Aral Sea
Adriatic Sea
Bay of Biscay
Persian Gulf
Red Sea
Gulf of Aden
Sahara Desert
Libyan Desert
Tropic of Cancer
SPAIN
PORTUGAL
ITALY
YUGOSLAVIA
ALBANIA
GREECE
BULGARIA
TURKEY
CYPRUS
SYRIA
LEB.
ISRAEL
JORDAN
IRAQ
IRAN (PERSIA)
SAUDI ARABIA
YEMEN
SOUTH YEMEN
EGYPT (U.A.R.)
LIBYA
TUNISIA
ALGERIA
MOROCCO
SPANISH SAHARA
MAURITANIA
MALI
NIGER
CHAD
SUDAN
ETHIOPIA
T.F.A.I.
SENEGAL
GAMBIA
PORT. GUINEA
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
GHANA
UPPER VOLTA
NIGERIA
Madeira
Canary Is.
Balearic Is.
Corsica
Sardinia
Sicily
Malta
Crete
Rhodes
Bordeaux
Madrid
Barcelona
Marseilles
Turin
Milan
Genoa
Rome
Naples
Palermo
Trieste
Belgrade
Bucharest
Sofia
Istanbul
Athens
Izmir
Ankara
Konya
Erzurum
Tbilisi
Baku
Tabriz
Tehran
Mosul
Kirkuk
Baghdad
Basra
Kuwait
Bushire
Aleppo
Damascus
Beirut
Amman
Jerusalem
Tel Aviv-Jaffa
Haifa
Port Said
Suez
Cairo
Alexandria
Asyut
Luxor
Aswan
Medina
Mecca
Jiddah
Riyadh
Port Sudan
Suakin
Wadi Halfa
Atbara
Khartoum
Omdurman
El Obeid
El Fasher
Malakal
Wau
Asmera
Mesewa
Adua
Addis Ababa
Dire Dawa
Djibouti
Aden
Berbera
Sana
Lisbon
Oporto
Gibraltar
Ceuta (Sp.)
Tangier
Fes
Rabat
Casablanca
Marrakesh
Mogador
Safi
Ifni
Algiers
Oran
Constantine
Tunis
Sfax
Tripoli
Benghazi
Derna
Tobruk
Murzuk
Ghadames
Bardai
Fort Lamy
Bilma
Agades
Zinder
Niamey
Sokoto
Kano
Kaduna
Jos
Lagos
Ibadan
Bamako
Kayes
Tombouctou
Bobo Diulasso
Dakar
St. Louis
Bathurst
Conakry
Freetown
Monrovia
Abidjan
Kumasi
Tamale
Villa Cisneros
Las Palmas
Santa Cruz
Tenerife
C. Finisterre
C. St. Vincent
Elbrus 18481'

Projection: Sanson Flamsteed Sinusoidal


D 140 E F 120 G H 100 J K 80 L
GREENLAND
(to Denmark)
Angmagssalik
C. Farewell
Julianehaab
Frederikshaab
Godthaab
Holsteinsborg
Jacobshavn
Disko I.
Davis Strait
Baffin Bay
Upernavik
Thule
12,200
Cumberland Sound
Frobisher Sd.
C. Chidley
Hudson Str.
Ungava Bay
Baffin I.
Foxe Basin
Foxe Channel
Melville Pen.
Southampton I.
HUDSON BAY
James Bay
Belcher Is.
Sverdrup Is.
Ellesmere I.
Jones Sound
Devon I.
Lancaster Sound
Barrow Strait
North Magnetic Pole
Parry Is.
Melville I.
Prince Patrick I.
M'Clure Strait
Banks I.
Prince of Wales I.
M'Clintock Chan.
Boothia Pen.
G. of Boothia
Prince Albert Pen.
Victoria I.
BEAUFORT SEA
C. Bathurst
Inuvik
Ft. McPherson
Mackenzie
Norman
Great Bear L.
Port Radium
Yellowknife
Great Slave L.
Ft. Resolution
Ft. Smith
Ft. Simpson
Hay River
Thelon
Chesterfield Inlet
Churchill
Port Nelson
Nelson
Lynn Lake
Flin Flon
The Pas
Fond du Lac
Athabasca L.
Reindeer L.
Ft. McMurray
Athabasca
Peace
Peace River
Ft. Vermilion
Cariboo Mts.
Finlay
Prince George
Mt. Robson 12972
Ft. Fraser
Edmonton
Prince Albert
Saskatoon
L. Winnipegosis
L. Manitoba
L. Winnipeg
Winnipeg
Yorkton
Regina
Moose Jaw
Brandon
Medicine Hat
Calgary
Kicking Horse Pass
Lethbridge
Selkirk Mts.
Kamloops
Mt. Waddington 13,260
Fraser
Vancouver
Vancouver I.
Victoria
Str. of Juan de Fuca
Queen Charlotte Is.
Queen Charlotte Sound
Prince Rupert
Ketchikan
Sitka
Juneau
Skagway
Whitehorse
Dawson
Coast Range
ROCKY MTS.
CANADA
Kaniapiskau
Schefferville
Labrador
Laurentian Plateau
Gagnon
Sept Iles
Churchill
Goose Bay
Leaf
East Main
Moosonee
Hearst
Cochrane
Rouyn
L. Nipigon
Port Arthur
Ft. William
L. Superior
Sault Ste. Marie
Sudbury
Kenora
L. of the Woods
Duluth
Quebec
Trois Rivières
Montreal
Ottawa
Kingston
Toronto
Hamilton
Niagara Falls
L. Ontario
Rochester
Buffalo
Saguenay
Rivière du Loup
St. Lawrence
Sherbrooke
Moncton
Saint John
Halifax
Charlottetown
Prince Edward I.
Sydney
Anticosti I.
G. of St. Lawrence
St. Pierre & Miquelon (Fr.)
Newfoundland
St. John's
Gander
Strait of Belle Isle
C. Charles
Augusta
Portland
Boston
Providence
Hartford
New Haven
Long I.
Hudson
C. Sable
Michigan
Green Bay
St. Paul
Minneapolis
Mississippi
Fargo
Grand Forks
Missouri
Yellowstone
Yellowstone National Park
Helena
Butte
Spokane
Boise
Snake
Everett
Seattle
Tacoma
Mt. Rainier 14,408
Yakima
Columbia
Portland
Salem
Klamath
ALASKA
Brooks Ra.
Pt. Barrow
Arctic Circle
Circle
Fairbanks
Yukon
Alaska Ra.
Mt. McKinley 20,320
Mt. Logan 19,850
Mt. Saint Elias 18,008
Cordova
Seward
Anchorage
Gulf of Alaska
Kodiak I.
Kuskokwim
Alaska Pen.
Bristol Bay
Nunivak
Seward Pen.
Nome
Norton Sd.
Bering Strait
St. Lawrence I.
U.S.S.R.
ASIA
PA

Projection: Bonne

Projection : Conical


UNITED STATES
Scale 1 : 25,000,000 (400 miles = 1 inch)
100 0 100 200 300 400 500 Statute Miles
100 0 100 200 300 400 500 600 700 800 Kilometres
Railways
West from Greenwich
Project on : Bonne
ATLANTIC OCEAN
GULF OF MEXICO
Winnipeg
Superior
L. Nipigon
Lake of the Woods
Port Arthur
Fort William
L. Superior
Moosonee
Cochrane
Franz
Cobalt
Sudbury
North Bay
Saulte Ste Marie
Quebec
Trois Rivières
Montreal
Ottawa
Kingston
Toronto
Hamilton
London
Niagara Falls
Saint John
Saguenay
Gaspé Pen.
Fredericton
MAINE
Bangor
Augusta
Lewiston
Portland
Sherbrooke
Champlain
VT.
N.H.
Manchester
Lawrence
Boston
C. Cod
Fall River
Providence
RHODE I.
MASS.
CONN.
Albany
Newhaven
Long I.
New York
NEW JERSEY
Jersey City
Newark
Trenton
Philadelphia
Wilmington
Baltimore
DELAWARE
MARYLAND
Washington (D.C.)
Richmond
Norfolk
Portsmouth
VIRGINIA
W. VIRGINIA
Winston-Salem
Durham
Raleigh
C. Hatteras
N. CAROLINA
Mt. Mitchell 6684
Charlotte
Greenville
Wilmington
S. CAROLINA
Columbia
Charleston
Augusta
Atlanta
Macon
GEORGIA
Savannah
Albany
Columbus
Jacksonville
S. Augustine
Tallahassee
FLORIDA
Orlando
Tampa
St. Petersburg
L. Okeechobee
W. Palm Beach
Ft. Lauderdale
Miami
Florida Str.
Bahama Is. (Br.)
Nassau
Rochester
Syracuse
NEW YORK
Hudson
Buffalo
Erie
L. Ontario
L. Erie
Cleveland
PENNSYLVANIA
Pittsburgh
Akron
Youngstown
OHIO
Columbus
Toledo
Detroit
Lansing
Grand Rapids
Bay City
Huron
Alpena
Mackinaw
Manistee
MICHIGAN
L. Michigan
Marquette
Cincinnati
Dayton
Covington
Louisville
Lexington
KENTUCKY
Knoxville
Nashville
TENNESSEE
Chattanooga
Cumberland
Appalachian
Gadsden
Birmingham
Tuscaloosa
ALABAMA
Montgomery
Mobile
Pensacola
Meridian
Jackson
MISSISSIPPI
Vicksburg
Biloxi
New Orleans
Mississippi Delta
Baton Rouge
LOUISIANA
L. Charles
Port Arthur
Shreveport
Monroe
Alexandria
Beaumont
Houston
Galveston
San Antonio
Corpus Christi
Waco
Dallas
Sherman
Denison
Texarkana
Hot Springs
Little Rock
Pine Bluff
ARKANSAS
Memphis
Ft. Smith
Muskogee
Tulsa
OKLAHOMA
Lawton
Red
Joplin
Springfield
Ozark Plat.
MISSOURI
Kansas City
St. Joseph
St. Louis
Evansville
Paducah
Cairo
Springfield
Peoria
ILLINOIS
Indianapolis
INDIANA
Fort Wayne
South Bend
Gary
Chicago
Aurora
Milwaukee
Madison
Green Bay
WISCONSIN
Eau Claire
Wausau
St. Paul
Minneapolis
MINNESOTA
Duluth
Superior City
Grand Forks
Crookston
Fergus Falls
St. Cloud
Rochester
La Crosse
Sioux Falls
Yankton
Waterloo
IOWA
Cedar Rapids
Des Moines
Davenport
Ottumwa
Omaha
Council Bluffs
Topeka
Leavenworth
Hutchinson
Pittsburg
ALEUTIAN ISLANDS
Scale 1 : 25,000,000 (400 miles = 1 inch)
100 0 100 200 300 Miles
100 0 100 200 300 400 500 Km.
Aleutian Islands
Attu I.
Agattu I.
Semisopochnoi I.
Buldir I.
Near Is.
Kiska I.
Rat Is.
Tanaga
Adak
Atka I.
Davis
Andreanof Is.
Amchitka I.
Seguam I.
Amukta Passage
Amlia I.
Unimak I.
Dutch Harbor
Unalaska I.
Umnak I.
I. of Four Mountains
Fox Is.
PACIFIC OCEAN
E. from Greenwich
W. from Greenwich
HAWAII
Scale 1 : 10,000,000
20 0 20 40 60 80 Miles
25 0 25 50 75 100 125 Km.
West from Greenwich
PACIFIC OCEAN
Oahu
Honolulu
Kalaupapa
Molokai
Lanai
Maui
Hana
Lahaina
Haleakala 10,025
Makena
Kahoolawe
Alenuihaha Channel
Kohala
Mahukona
Kamuela
Kawaihae
Paauilo
Hawaii
Mauna Kea 13,784
Hilo
Mauna Loa 13,680
Keaau
Kapoho
Kailua
Glenwood
Kilauea Crater 4090
Pahala


Caribbean Sea
NORTH ATLANTIC OCEAN
CENTRAL AMERICA
LESSER ANTILLES
WINDWARD ISLANDS
HONDURAS
NICARAGUA
COSTA RICA
PANAMA
CANAL ZONE
VENEZUELA
COLOMBIA
ECUADOR
PERU
BOLIVIA
BRAZIL
GUYANA
SURINAM
FR. GUIANA
Tegucigalpa
Managua
San José
Barranquilla
Cartagena
Maracaibo
Barquisimeto
Caracas
Valencia
Port of Spain
Trinidad
Barbados
Martinique
St. Lucia
St. Vincent
Grenada
Tobago I.
Curaçao
Bonaire
Aruba
Georgetown
Paramaribo
Cayenne
Medellín
Bogotá
Cali
Cúcuta
Bucaramanga
San Cristóbal
Quito
Guayaquil
Cuenca
Iquitos
Lima
Callao
Cuzco
Arequipa
La Paz
Cochabamba
Oruro
Sucre
Manaus
Belém
São Luís
Fortaleza
Natal
João Pessoa
Recife
Maceió
Aracaju
Salvador
Brasília
Belo Horizonte
Santarém
Óbidos
Porto Velho
Cuiabá
Teresina
AMAZONAS
PARÁ
MARANHÃO
PIAUÍ
BAHIA
GOIÁS
MATO GROSSO
RONDÔNIA
RORAIMA
AMAPÁ
ACRE
Equator
Galapagos Is.
(Ecuador)
On same scale as general map

Projection: Lambert's Equivalent Azimuthal

Projection: Bonne


AUSTRALIA
Scale 1:25,000,000 (400 miles = ·1 inch)
100 0 100 200 300 Statute Miles
100 0 100 200 300 400 Kilometres
Railways
9175 Heights in feet
Gulf of Papua
Mt. Victoria 13,120
Owen Stanley Ra.
Torres Str.
P. Moresby
Thursday I.
C. York
China Strait
C Arnhem
Cape York Peninsula
Gulf of Carpentaria
Great Barrier Reef
Coral Sea
Mitchell
Laura
Cooktown
Cairns
Van Diemen
Normanton
Croydon
Forsayth
Tableland
Leichhardt
Burdekin
Townsville
Mt. Cuthbert
Mt. Isa
Flinders
Great Dividing Range
Charters Towers
Cloncurry
Selwyn
Dajarra
QUEENSLAND
Mackay
Winton
Capricorn
Longreach
Barcoo
Rockhampton
Mt. Morgan
Gladstone
Fitzroy
Yaraka
Diamantina
Bundaberg
Sandy C.
PACIFIC OCEAN
Maryborough
Charleville
Quilpie
Gympie
Cooper
Warrego
Culgoa
Darling
Ipswich
Brisbane
Cunnamulla
Toowoomba
Dirranbandi
Downs
Warwick
Mt. Lindesay 4064
C. Byron
Lismore
New England Ra.
Barwon
Walgett
Bourke
L. Frome
Flinders Range
Grafton
Tamworth
Armidale
NEW SOUTH WALES
Broken Hill
Darling
Cobar
Macquarie
Mt 3100
Seaview
Lofty Range
Whyalla
Murray
Lachlan
W. Maitland
Newcastle
Lithgow
Bathurst
Parramatta
Blue Mountains
Main Ra.
Sydney
Port Jackson
Botany Bay
Adelaide
Mildura
Hay
Murrumbidgee
Wollongong
Goulburn
Riverina
Vincent Gulf
Encounter B.
Albury
Wagga Wagga
Jervis Bay
Canberra
Austral. Cap. Terr.
Mt Kosciusko 7328
Kingston
VICTORIA
Maryborough
Bendigo
Australian Alps
Ballarat
Melbourne
Bombala
Geelong
C. Howe
Orbost
Portland
Warrnambool
Port Phillip B.
Port Albert
Wilson Promontory
Bass Strait
King I.
Flinders I.
TASMANIA
Mt. Ossa 5309
Launceston
Ben Lomond
Queenstown
Hobart
OCEAN
East from Greenwich
C. Maria van Diemen
North C.
Russell
Whangarei
Hauraki Gulf
Kaipara Harb.
Gt. Barrier I.
Auckland
Thames
Bay of Plenty
Hamilton
NORTH ISLAND
Waikato
Rotorua
East C.
Kawerau
New Plymouth
L. Taupo
Gisborne
Mt Egmont 8260
Ruapehu 9175
Mahia Pen.
Hawke B.
Wanganui
Napier
Palmerston N.
Hastings
C. Farewell
Cook Strait
Wellington
Nelson
Picton
C. Palliser
Greymouth
Hokitika
Southern Alps
Plains
SOUTH ISLAND
Mt. Cook 12,349
Canterbury
Christchurch
& Lyttelton
Bank's Pen.
PACIFIC OCEAN
Timaru
Waitaki
Oamaru
Doubtful Sd.
Te Anau
Dunedin
& P. Chalmers
West C.
Foveaux Strait
Invercargill
Stewart I.
Bluff Hr.
South C.
NEW ZEALAND
On the same scale

Projection: *Zenithal Equidistant*

Marconi Diary

THE MARCONI COMPANY LIMITED
CHELMSFORD · ESSEX · ENGLAND

Telephone: Chelmsford 53221 Telex: 99201
Telegrams: Expanse Chelmsford Telex.

Contents

Some Notable Dates

1831 Michael Faraday evolved theory of electro-magnetic induction

1873 James Clerk Maxwell published his Treatise on Electricity and Magnetism

1874 April 25th. Guglielmo Marconi born at Bologna

1875 Alexander Graham Bell invented the telephone

1883 Basic television scanning device conceived by Paul Nipkow

1888 Heinrich Hertz demonstrated electro-magnetic waves

1890 Edouard Branly devised the coherer, first detector of wireless waves

1896 Marconi arrived in England and took out first patent for system of wireless telegraphy

1897 July 20th. World's first wireless manufacturing company (Marconi's) incorporated

1899 March 27th. First international wireless message sent by Marconi System from Wimereux to South Foreland

1901 December 12th. Marconi at Signal Hill, Newfoundland, received first transatlantic wireless signal from Poldhu, Cornwall

1904 Ambrose Fleming's patent for first thermionic valve

1905 Marconi's patent for first directional long wave aerial

1906 Lee DeForest's patent for the triode

1907 October 17th. Marconi's opened first commercial transatlantic wireless service between Clifden, Ireland and Glace Bay, Nova Scotia

1908 Campbell Swinton made first published suggestion of all-electronic television

1910 First air-to-ground wireless message sent by Canadian airman J. D. A. McCurdy at Long Island

1911 Campbell Swinton elaborated on his ideas for "distant electric vision"

1912 Marconi's acquired Bellini-Tosi patents and developed direction finder

1913 Alexander Meissner showed that valve could generate oscillations

1915 First speech west to east across Atlantic, from Arlington, Va. to Paris

1916 First radiotelephone message to flying aircraft, Major C. E. Prince at Brooklands Aerodrome
Marconi's short wave beam tests at Livorno

1918 First wireless message from England to Australia sent from Marconi Caernarvon station

1919 Voice of W. T. Ditcham, Marconi engineer, first to cross Atlantic east to west, Ballybunion to Louisberg
Experimental broadcasts began from Marconi works, Chelmsford

1920 June 15th. Dame Melba broadcast from Marconi works, Chelmsford, Britain's first advertised programme of public broadcasting entertainment
February 23rd. World's first wireless telephony news service began from Chelmsford
November 2nd. World's first regular broadcasting station, KDKA Pittsburgh, went on the air

1922 February 14th. Britain's first regular broadcast service began from Marconi station 2MT Writtle
May 11th. First broadcast from Marconi London station 2LO
November 14th. BBC born and commenced operating from 2LO

1924 Marconi revealed discovery of short wave beam system for long distance communication

1925 John Logie Baird gave first public demonstration of television in Britain

1926 May 1st. Commercial radio facsimile service opened between London and New York
October 25th. First Marconi-Franklin short wave beam system opened between Britain and Canada

1927 November 11th. BBC's 5SW short wave station at Chelmsford opened for experimental broadcasts to Empire

1928 Baird first transmitted colour

1929 First Baird television experimental programmes broadcast by BBC
Vladimir Zworykin demonstrated iconoscope camera tube in New York

1932 Marconi's installed world's first microwave radiotelephone link between Vatican City and Castel Gandolfo

1933 First demonstration of communication by tropospheric scatter by Marconi at Santa Margherita

1935 Marconi demonstrated principles of radar at Torre Chiaruccia

1936 November 2nd. World's first public television service inaugurated by BBC using Marconi-EMI system

1937 July 20th. Guglielmo Marconi died in Rome

1939–45 Second world war. The advent of radar and the cavity magnetron. First full particulars of radar published 1945

1948 The transistor announced by Bell Telephone Laboratories

1954 Marconi's gave first public demonstration of compatible colour television in Britain

1955 September 13th. Britain's first commercial television station, Marconi-equipped, opened at Croydon
BBC began experimental colour television broadcasts, using Marconi equipment

1957 Jodrell Bank radiotelescope opened

1961 April 12th. First man into space (Major Gagarin)

1965 Early Bird, first of the synchronous orbit, commercial communications network satellites in service during June.

Weights and Measures

LINEAR MEASURE:

12 inches	=	1 foot
3 feet	=	1 yard
5½ yards	=	1 pole
22 yards	=	1 chain
220 yards	=	1 furlong
1,760 yards	=	1 mile

SQUARE MEASURE:

144 square inches	=	1 square foot
9 square feet	=	1 square yard
30¼ square yards	=	1 perch
40 perches	=	1 rood
4 roods	=	1 acre
4,840 square yards	=	1 acre
640 acres	=	1 square mile

CUBIC MEASURE:

1,728 cubic inches	=	1 cubic foot
27 cubic feet	=	1 cubic yard

CAPACITY MEASURE:

4 gills	=	1 pint
2 pints	=	1 quart
4 quarts	=	1 gallon
2 gallons	=	1 peck
8 gallons	=	1 bushel
8 bushels	=	1 quarter

APOTHECARIES' MEASURE

60 minims	=	1 fluid drachm
8 drachms	=	1 fluid ounce
20 fluid ounces	=	1 pint
8 pints	=	1 gallon

AVOIRDUPOIS WEIGHT:

27·3 (approx) grains	=	1 dram
16 drams (437·5 grains)	=	1 ounce
16 ounces	=	1 pound
14 pounds	=	1 stone
2 stones	=	1 quarter
4 quarters	=	1 hundredweight
112 pounds	=	1 hundredweight
20 hundredweights	=	1 ton

APOTHECARIES' WEIGHT:

20 grains	=	1 scruple
3 scruples	=	1 drachm
8 drachms	=	1 ounce

METRIC SYSTEM:

Prefixes

pico	=	$\times 10^{-12}$
nano	=	$\times 10^{-9}$
micro	=	$\times 10^{-6}$
milli	=	$\times 10^{-3}$
centi	=	$\times 10^{-2}$
deci	=	$\times 10^{-1}$
deka	=	$\times 10$
hecto	=	$\times 10^{2}$
kilo	=	$\times 10^{3}$
myria	=	$\times 10^{4}$
mega	=	$\times 10^{6}$
giga	=	$\times 10^{9}$
tera	=	$\times 10^{12}$

Units

linear	=	metre
capacity	=	litre
weight	=	gram

NB.

100 kilograms	=	1 quintal
1000 kilograms	=	1 tonne
100 square metres	=	1 are

Conversion Tables

NOTE ON USING CONVERSION TABLES:

There are no cross-references in the following table; conversion factor will be found listed under one but not both units concerned.

To convert A to B multiply by	*A*	*B*	*To convert B to A multiply by*
1×10^{-8}	Angström units	centimetres	1×10^{8}
$3{\cdot}937 \times 10^{-9}$	Angström units	inches	$2{\cdot}539998 \times 10^{8}$
1×10^{-4}	Angström units	microns	1×10^{4}
$2{\cdot}5198 \times 10^{2}$	Btu	calories	$3{\cdot}9685 \times 10^{-3}$
$1{\cdot}0548 \times 10^{3}$	Btu	joules	$9{\cdot}480 \times 10^{-4}$
$2{\cdot}930 \times 10^{-4}$	Btu	kilowatt-hours	$3{\cdot}41304 \times 10^{3}$
$1{\cdot}0548 \times 10^{3}$	Btu	watt-seconds	$9{\cdot}480 \times 10^{-4}$
$6{\cdot}08 \times 10^{2}$	cable lengths	feet	$1{\cdot}644 \times 10^{-3}$
$2{\cdot}1946 \times 10^{2}$	cable lengths	metres	$4{\cdot}5566 \times 10^{-3}$
4·186	calories (gram)	joules	$2{\cdot}3889 \times 10^{-1}$
$1{\cdot}1628 \times 10^{-3}$	calories (gram)	watt-hours	$8{\cdot}6001 \times 10^{2}$
$3{\cdot}937011 \times 10^{-1}$	centimetres	inches	2·539998
1×10^{4}	centimetres	microns	1×10^{-4}
$3{\cdot}531477 \times 10^{-5}$	cubic centimetres	cubic feet	$2{\cdot}831677 \times 10^{4}$
$3{\cdot}5196 \times 10^{-2}$	cubic centimetres	ounces (fluid)	$2{\cdot}84130 \times 10^{1}$
$1{\cdot}63870253 \times 10^{1}$	cubic inches	cubic centimetre	$6{\cdot}10234 \times 10^{-2}$
$5{\cdot}78704 \times 10^{-4}$	cubic inches	cubic feet	$1{\cdot}728 \times 10^{3}$
$3{\cdot}60464 \times 10^{-3}$	cubic inches	gallons	$2{\cdot}77418 \times 10^{2}$
$5{\cdot}7674 \times 10^{-1}$	cubic inches	ounces (fluid)	1·734
$1{\cdot}74533 \times 10^{-2}$	degrees	radians	$5{\cdot}729578 \times 10^{1}$
$6{\cdot}0 \times 10^{1}$	drachms	grains	$1{\cdot}6667 \times 10^{-2}$
3·8879351	drachms	grams	$2{\cdot}57206 \times 10^{-1}$
$1{\cdot}371429 \times 10^{-1}$	drachms	ounces (avoirdupois)	7·29166
$1{\cdot}25 \times 10^{-1}$	drachms	ounces (troy)	8
$4{\cdot}557292 \times 10^{-1}$	drams	drachms	2·194286
$2{\cdot}734375 \times 10^{1}$	drams	grains	$3{\cdot}657143 \times 10^{-2}$
1·771845	drams	grams	$5{\cdot}64383 \times 10^{-1}$
$5{\cdot}6966146 \times 10^{-2}$	drams	ounces (troy)	$1{\cdot}755428 \times 10^{1}$
$1{\cdot}019 \times 10^{-3}$	dynes	grams	$9{\cdot}80665 \times 10^{2}$
$7{\cdot}2330 \times 10^{-5}$	dynes	poundals	$1{\cdot}38255 \times 10^{4}$
$\frac{1}{6}$	ems, pica	inches	6
$9{\cdot}4805 \times 10^{-11}$	ergs	Btu	$1{\cdot}0548 \times 10^{10}$
$2{\cdot}3889 \times 10^{-8}$	ergs	calories	$4{\cdot}186 \times 10^{7}$
$6{\cdot}2422 \times 10^{-11}$	ergs	electron-volts	$1{\cdot}603 \times 10^{-12}$
$2{\cdot}3730 \times 10^{-6}$	ergs	foot-poundals	$4{\cdot}21402 \times 10^{5}$
1×10^{-7}	ergs	joules	1×10^{7}
$6{\cdot}702 \times 10^{4}$	ergs	mass units	$1{\cdot}4921 \times 10^{-5}$
$8{\cdot}3333 \times 10^{-3}$	fathoms	cable lengths	$1{\cdot}20 \times 10^{2}$
1·828804	fathoms	metres	$5{\cdot}4683 \times 10^{-1}$
$3{\cdot}047997 \times 10^{1}$	feet	centimetres	$3{\cdot}284 \times 10^{-2}$
$4{\cdot}5460858 \times 10^{3}$	gallons	cubic centimetres	$2{\cdot}1997 \times 10^{-4}$
$2{\cdot}77418 \times 10^{2}$	gallons	cubic inches	$3{\cdot}60464 \times 10^{-3}$
$6{\cdot}4798918 \times 10^{-2}$	grains	grams	$1{\cdot}54324 \times 10^{1}$
$2{\cdot}2857 \times 10^{-3}$	grains	ounces (avoirdupois)	$4{\cdot}375 \times 10^{2}$
$2{\cdot}0833 \times 10^{-3}$	grains	ounces (troy)	$4{\cdot}80 \times 10^{2}$
$3{\cdot}52739 \times 10^{-2}$	grams	ounces (avoirdupois)	$2{\cdot}8349527 \times 10^{1}$
$3{\cdot}21507 \times 10^{-2}$	grams	ounces (troy)	$3{\cdot}1103481 \times 10^{1}$
$9{\cdot}80665 \times 10^{2}$	gravity (acceleration)	centimetres/sec^{2}	$1{\cdot}019 \times 10^{-3}$
$3{\cdot}2174 \times 10^{1}$	gravity (acceleration)	feet/sec^{2}	$3{\cdot}1081 \times 10^{-2}$

To convert A to B multiply by	*A*	*B*	*To convert B to A multiply by*
$2{\cdot}3730 \times 10^{1}$	joules	foot-poundals	$4{\cdot}21402 \times 10^{-2}$
$2{\cdot}778 \times 10^{-4}$	joules	watt-hours	$3{\cdot}600 \times 10^{3}$
$3{\cdot}280843 \times 10^{4}$	kilometres	feet	$3{\cdot}047997 \times 10^{-4}$
$6{\cdot}21373 \times 10^{-1}$	kilometres	miles	$1{\cdot}6093425$
$1{\cdot}15155$	knots	miles/hour	$8{\cdot}6839 \times 10^{-1}$
$3{\cdot}5316 \times 10^{-2}$	litres	cubic feet	$2{\cdot}831677 \times 10^{1}$
$6{\cdot}1025 \times 10^{1}$	litres	cubic inches	$1{\cdot}638658 \times 10^{-2}$
$2{\cdot}19976 \times 10^{-1}$	litres	gallons	$4{\cdot}5460858$
$3{\cdot}5196 \times 10^{1}$	litres	ounces (fluid)	$2{\cdot}841 \times 10^{-2}$
$3{\cdot}280843$	metres	feet	$3{\cdot}047997 \times 10^{-1}$
1×10^{-6}	metres	microns	1×10^{-6}
$5{\cdot}39593 \times 10^{-4}$	metres	miles (nautical)	$1{\cdot}852 \times 10^{3}$
$6{\cdot}2137 \times 10^{-4}$	metres	miles (statute)	$1{\cdot}6093425 \times 10^{3}$
$3{\cdot}937 \times 10^{-5}$	microns	inches	$2{\cdot}539998 \times 10^{4}$
$6{\cdot}080 \times 10^{3}$	miles (nautical)	feet	$1{\cdot}644 \times 10^{-4}$
$4{\cdot}47041 \times 10^{1}$	miles/hour	centimetres/sec.	$2{\cdot}2369 \times 10^{-2}$
$8{\cdot}8 \times 10^{1}$	miles/hour	feet/min.	$1{\cdot}1364 \times 10^{-2}$
$9{\cdot}114583 \times 10^{-1}$	ounces (avoirdupois)	ounces (troy)	$1{\cdot}09714$
$7{\cdot}5954861 \times 10^{-2}$	ounces (avoirdupois)	pounds (troy)	$1{\cdot}3165714 \times 10^{1}$
$6{\cdot}857143 \times 10^{-2}$	ounces (troy)	pounds (avoirdupois)	$1{\cdot}45833 \times 10^{1}$
$3{\cdot}5278 \times 10^{-2}$	points (printers)	centimetres	$2{\cdot}835 \times 10^{1}$
$1{\cdot}38889 \times 10^{-2}$	points (printers)	inches	$7{\cdot}2 \times 10^{1}$
$\frac{1}{12}$	points (printers)	picas (ems)	$1{\cdot}2 \times 10^{1}$
$1{\cdot}40981 \times 10^{1}$	poundals	grams	$7{\cdot}09314 \times 10^{-2}$
$2{\cdot}56 \times 10^{2}$	pounds (avoirdupois)	drams	$3{\cdot}90625 \times 10^{-3}$
$1{\cdot}166667 \times 10^{2}$	pounds (avoirdupois)	drachms	$8{\cdot}571429 \times 10^{-3}$
7×10^{3}	pounds (avoirdupois)	grains	$1{\cdot}429 \times 10^{-4}$
$4{\cdot}535924277 \times 10^{2}$	pounds (avoirdupois)	grams	$2{\cdot}20462 \times 10^{-3}$
$3{\cdot}2174 \times 10^{1}$	pounds (avoirdupois)	poundals	$3{\cdot}1081 \times 10^{-2}$
$1{\cdot}2152778$	pounds (avoirdupois)	pounds (troy)	$8{\cdot}22857 \times 10^{-1}$
$2{\cdot}106514 \times 10^{2}$	pounds (troy)	drams	$4{\cdot}7471788 \times 10^{-3}$
$5{\cdot}760 \times 10^{3}$	pounds (troy)	grains	$1{\cdot}736 \times 10^{-4}$
$3{\cdot}732418 \times 10^{2}$	pounds (troy)	grams	$2{\cdot}67923 \times 10^{-3}$
$1{\cdot}076393 \times 10^{-3}$	square centimetres	square feet	$9{\cdot}290289 \times 10^{2}$
$1{\cdot}5500056 \times 10^{-1}$	square centimetres	square inches	$6{\cdot}4515898$
$3{\cdot}586 \times 10^{-8}$	square feet	square miles	$2{\cdot}78784 \times 10^{7}$
$2{\cdot}471058 \times 10^{2}$	square kilometres	acres	$4{\cdot}046849 \times 10^{-3}$
$3{\cdot}861028 \times 10^{-1}$	square kilometres	square miles	$2{\cdot}589998$
$1{\cdot}1960 \times 10^{6}$	square kilometres	square yards	$8{\cdot}361259 \times 10^{5}$
$6{\cdot}40 \times 10^{2}$	square miles	acres	$1{\cdot}562 \times 10^{-3}$
$2{\cdot}47$	hectares	acres	$4{\cdot}05 \times 10^{-1}$
$1{\cdot}0160470 \times 10^{3}$	tons	kilograms	$9{\cdot}84207 \times 10^{-4}$
$3{\cdot}584 \times 10^{4}$	tons	ounces (avoirdupois)	$2{\cdot}790 \times 10^{-5}$
$2{\cdot}72222 \times 10^{3}$	tons	pounds (troy)	$3{\cdot}673 \times 10^{-4}$
$2{\cdot}6553 \times 10^{3}$	watt-hours	foot-pounds	$3{\cdot}7662 \times 10^{-4}$
$3{\cdot}6 \times 10^{3}$	watt-hours	joules	$2{\cdot}77778 \times 10^{-4}$
$1{\cdot}3410 \times 10^{-3}$	watts	horsepower	$7{\cdot}4570 \times 10^{2}$
1×10^{-3}	mils	radians	1×10^{3}
$5{\cdot}729578 \times 10^{-2}$	mils	degrees	$1{\cdot}74533 \times 10^{1}$
$3{\cdot}4377468$	mils	minutes	$0{\cdot}29089$

International Atomic Weights

		At. No.	At. Wt.			At. No.	At. Wt.
Actinium	Ac	89	227	Molybdenum	Mo	42	95·95
Aluminium	Al	13	26·98	Neodymium	Nd	60	144·27
Americium	Am	95	243	Neptunium	Np	93	237
Antimony	Sb	51	121·76	Neon	Ne	10	20·183
Argon	A	18	39·944	Nickel	Ni	28	58·71
Arsenic	As	33	74·91	Niobium	Nb	41	92·91
Astatine	At	85	210	Nitrogen	N	7	14·008
Barium	Ba	56	137·36	Osmium	Os	76	190·2
Berkelium	Bk	97	249	Oxygen	O	8	16
Beryllium	Be	4	9·013	Palladium	Pd	46	106·4
Bismuth	Bi	83	209·00	Phosphorus	P	15	30·975
Boron	B	5	10·82	Platinum	Pt	78	195·09
Bromine	Br	35	79·916	Plutonium	Pu	94	242
Cadmium	Cd	48	112·41	Polonium	Po	84	210
Calcium	Ca	20	40·08	Potassium	K	19	39·100
Californium	Cf	98	249	Praseodymium	Pr	59	140·92
Carbon	C	6	12·011	Promethium	Pm	61	145
Cerium	Ce	58	140·13	Protoactinium	Pa	91	231
Caesium	Cs	55	132·91	Radium	Ra	88	226·05
Chlorine	Cl	17	35·457	Radon	Rn	86	222
Chromium	Cr	24	52·01	Rhenium	Re	75	186·22
Cobalt	Co	27	58·94	Rhodium	Rh	45	102·91
Copper	Cu	29	63·54	Rubidium	Rb	37	85·48
Curium	Cm	96	245	Ruthenium	Ru	44	101·1
Dysprosium	Dy	66	162·51	Samarium	Sm	62	150·35
Erbium	Er	68	167·27	Scandium	Sc	21	44·96
Europium	Eu	63	152·0	Selenium	Se	34	78·96
Fluorine	F	9	19·00	Silicon	Si	14	28·09
Francium	Fr	87	223	Silver	Ag	47	107·880
Gadolinium	Gd	64	157·26	Sodium	Na	11	22·991
Gallium	Ga	31	69·72	Strontium	Sr	38	87·63
Germanium	Ge	32	72·60	Sulphur	S	16	32·066
Gold	Au	79	197·0	Tantalum	Ta	73	180·95
Hafnium	Hf	72	178·50	Technetium	Tc	43	99
Helium	He	2	4·003	Tellurium	Te	52	127·61
Holmium	Ho	67	164·94	Terbium	Tb	65	158·93
Hydrogen	H	1	1·008	Thallium	Tl	81	204·39
Indium	In	49	114·82	Thorium	Th	90	232·05
Iodine	I	53	126·91	Thulium	Tm	69	168·94
Iridium	Ir	77	192·2	Tin	Sn	50	118·70
Iron	Fe	26	55·85	Titanium	Ti	22	47·90
Krypton	Kr	36	83·80	Tungsten	W	74	183·86
Lanthanum	La	57	138·92	Uranium	U	92	238·07
Lead	Pb	82	207·21	Vanadium	V	23	50·95
Lithium	Li	3	6·940	Xenon	Xe	54	131·30
Lutetium	Lu	71	174·99	Ytterbium	Yb	70	173·04
Magnesium	Mg	12	24·32	Yttrium	Y	39	88·92
Manganese	Mn	25	54·94	Zinc	Zn	30	65·38
Mendelevium	Mv	101	256	Zirconium	Zr	40	91·22
Mercury	Hg	80	200·61				

Greek Alphabet and Symbols

alpha	A	α	angles, coefficients
beta	B	β	angles, coefficients
gamma	Γ	γ	specific gravity
delta	Δ	δ	density, increment, finite difference operator
epsilon	E	ϵ	hyperian logarithm, linear strain, permittivity
zeta	Z	ζ	co-ordinates, coefficients
eta	H	η	magnetic field strength, efficiency
theta	Θ	θ	angular displacement, time
iota	I	ι	inertia
kappa	K	κ	bulk modulus, magnetic susceptibility
lambda	Λ	λ	permeance, conductivity, wavelength
mu	M	μ	bending moment, coefficient of friction, permeability
nu	N	ν	kinematic viscosity, frequency, reluctivity
xi	Ξ	ξ	output coefficient
omicron	O	o	
pi	Π	π	circumference $\div$ diameter
rho	P	ρ	specific resistance
sigma	Σ	σ	summation
tau	T	τ	time constant
upsilon	Υ	υ	
phi	Φ	ϕ	flux, phase
chi	X	χ	
psi	Ψ	ψ	angular velocity, time
omega	Ω	ω	angular velocity

Technical Abbreviations and Symbols

Quantity	*Abbreviation*	*Symbol*
Admittance		Y
Alternating current	a.c.	
Ampere	A or amp	
Ampere hour	Ah	
Amplification factor		μ
Amplitude modulation	a.m.	
Angular velocity		ω
Audio frequency	a.f.	
Automatic frequency control	a.f.c.	
Automatic gain control	a.g.c.	
Automatic phase control	a.p.c.	
Bandwidth		Δf
Beat frequency oscillator	b.f.o.	
British thermal unit	Btu	
Capacitance		C
Cathode-ray oscilloscope	c.r.o.	
Cathode-ray tube	c.r.t.	
Centrigrade	C	
Centi-	c	
Centimetre	cm	
Square centimetre	cm^2	
or	sq. cm.	
Cubic centimetre	cm^3	
or	cu. cm.	
or	c.c.	
Centimetre-gramme-second	C.G.S.	
Conductance		G
Continuous wave	c.w.	
Coulomb	C	
Current density	c.d.	
Cycles per second	H_3	
Deci-	d	
Decibel	dB	

Quantity	*Abbreviation*	*Symbol*
Direct current	d.c.	
Direction finding	d.f.	
Double pole	d.p.	
Double throw	d.t.	
Double sideband	d.s.b.	
Efficiency		η
Equivalent isotropic radiated power	e.i.r.p.	
Electric charge		Q
Electric current		
steady or r.m.s.		I
instantaneous value		
Electromagnetic unit	e.m.u.	
Electromotive force	e.m.f.	E or V
instantaneous value		e or v
Electron volt	eV	
Electrostatic unit	e.s.u.	
Fahrenheit	F	
Farad	F	
Foot (feet)	ft.	
Frequency	freq.	
Frequency modulation	f.m.	
Gauss	G	
Giga-	G	
Gramme	g	
Henry	H	
High frequency	h.f.	
Hour	h	
Impedance		Z
Inch	in.	
Independent sideband	i.s.b.	
Inductance		L
Inductance mutual		M
Inductance-capacitance		L-C
Intermediate freq.	i.f.	

Technical Abbreviations and Symbols—*cont.*

Quantity	*Abbreviation*	*Symbol*
Kelvin	K	
Kilo-	k	
Kilocycles per second	kH_3	
Knot	kn	
Length		
Litre		
Local oscillator	l.o.	
Logarithm, common		log or $\log_{10}$
Logarithm, natural		ln or $\log_e$
Low frequency	l.f.	
Low tension	l.t.	
Magnetic field strength or Magnetising force		H
Magnetic induction or Magnetic flux density		B
Magnetomotive force	m.m.f.	F or M
Mass		m
Medium frequency	m.f.	
Mega-	M	
Megacycles per second	MH_3	
Metre	m	
Metre-kilogramme-second	M.K.S.	
Micro-	μ	
Micromicro	p	
Micron		μ
Milli-	m	
Modulated continuous wave	m.c.w.	

Quantity	*Abbreviation*	*Symbol*
Nano-	n	
Neper	N	
Noise factor		N
Ohm		Ω
Peak to peak	p-p	
Phase modulation	ph.m.	
Pico-	p	
Plan-position indication	PPI	
Potential difference	p.d.	V
Power factor	p.f.	
Pulse repetition frequency	p.r.f.	
Radian	rad	
Radio frequency	r.f.	
Radio telephony	R/T	
Reactance		X
Root mean square	r.m.s.	
Short-wave	s.w.	
Signal frequency	s.f.	
Standing wave ratio	s.w.r.	
Super-high frequency	s.h.f.	
Susceptance		B
Travelling-wave tube	t.w.t.	
Ultra-high frequency	u.h.f.	
Very high frequency	v.h.f.	
Very low frequency	v.l.f.	
Volt	V	
Voltage standing wave ratio	v.s.w.r.	
Watt	W	
Wavelength		λ
Weber	Wb	
Wireless telegraphy	W/T	

Physical Constants

Acceleration due to gravity $g = 980{\cdot}665$ cm./sec^2.

Avogadro's number $N = 6{\cdot}02380 \times 10^{23}$ molecules/mole.

Boltzmann's constant $k = 1{\cdot}380257 \times 10^{-16}$ ergs/degree/mole.

Charge to mass ratio for electron $e/m = 5{\cdot}27305 \times 10^{17}$ esu/gm.

Density of mercury $13{\cdot}59509$ gm./cm^3.

Electronic charge $e = 1{\cdot}601864 \times 10^{-19}$ coulombs.
$= 4{\cdot}80223 \times 10^{-10}$ esu

Faraday's constant $F = 96{,}493{\cdot}1$ coulombs/gm.-equivalent.

Gas constant $R = 8{\cdot}31439 \times 10^{7}$ ergs/degree/mole
$= 1{\cdot}98719$ calories/degree/mole.
$= 0{\cdot}0820544$ litre atmospheres/degree/mole.

Gravitational constant $G = 6{\cdot}670 \times 10^{-8}$ dynes-cm^2./gm^2.

Joule equivalent $J = 4{\cdot}1840$ joules/calorie

Latent heat of fusion of water $L_{\text{ice}} = 79{\cdot}63$ calories/gm. at 15°C.

Latent heat of vaporisation of water $L_{\text{steam}} = 539{\cdot}55$ calories/gm at 15°C.

Mass of electron $m = 9{\cdot}1083 \times 10^{-28}$ gm.

Planck's constant $h = 6{\cdot}62377 \times 10^{-27}$ erg-sec.
$\hbar = h/2\pi = 1{\cdot}05443 \times 10^{-27}$ erg-sec.

Radius of electron $r = 2{\cdot}81785 \times 10^{-13}$ cm.

Ratio of gas specific heats at constant pressure and constant volume

monatomic gas	$\gamma = 1{\cdot}667$
diatomic gas	$\gamma = 1{\cdot}41$
triatomic gas	$\gamma = 1{\cdot}28$

Rydberg constant for atom of infinite mass $R_\infty = 109737{\cdot}309$ cm^{-1}.

$\pi = 3{\cdot}141592654$	$e = 2{\cdot}718281828$
$1/\pi = 0{\cdot}318309886$	$\log_{10} e = 0{\cdot}43429$
$\pi^2 = 9{\cdot}869604401$	$\log_e 10 = 2{\cdot}302585$
$\log_{10}\pi = 0{\cdot}49715$	

Constants of Insulating Materials

Materials	Permittivity SIC				Power Factor				Dielectric strength volts/mil	Softening Point °C
	10^3Hz	10^6Hz	3×10^9Hz	2.5×10^{10}Hz	10^3Hz	10^6Hz	3×10^9Hz	2.5×10^{10}Hz		
Magnesium oxide	9·65	9·65	—	—	<0·00003	0·00003	—	—	—	—
Porcelain	5·36	5·08	—	—	0·0140	0·0075	—	—	—	—
Barium titanate	1200	1143	600	100	0.0130	0.0105	0·30	0·60	75	1400
Titanium dioxide Rutile	100	100	—	—	0·0015	0·0003	—	—	—	—
GLASS										
Soda, Potash— Lead silicate	6·70	6·65	6·64	6·51	0·003	0·0012	0·0041	0·0127	—	630
Pyrex	4·97	4·84	4·82	4·65	0.0055	0·0036	0·0054	0·0090	—	693
Fused silica	3·78	3·78	3·78	—	0·00026	0·00001	0·0001	—	—	—
Fused quartz	3·78	3·78	3·78	3·78	0·00075	0·0001	0·00006	0·00025	410	1667
PLASTICS										
Foamed di-isocyanate	1·223	1·218	1·20	—	0·00147	0·0041	0·0034	—	—	—
Epoxy resin	3·67	3·62	3·09	—	0·0024	0·019	0·027	—	405	109
100% phenol-Formaldehyde	7·15	5·4	3·64	—	0·082	0·060	0·052	—	277	150
75% P.T.F.E. 25% Fibreglass	2·14	2·14	—	—	0·00096	0·0007	—	—	—	—
50% phenol-Formaldehyde 50% paper Laminate	5·15	4·60	3·57	—	0·0165	0·034	0·060	—	—	—
Alkyd Potting resin	2·95	2·70	2·53	—	0·041	0·0124	0·0125	—	—	—
Unsaturated polyester	3·24	3·10	2·77	—	0·0072	0·0138	0·0130	—	—	—
Expanded P.V.C.	1·04	1·04	1·04	—	0·0011	0·0010	0·0055	—	—	—

Materials	Permittivity				Power Factor				Dielectric strength volts/mil	Softening Point °C
	10^3Hz	10^6Hz	3×10^9Hz	$2{\cdot}5\times10^{10}$Hz	10^3Hz	10^6Hz	3×10^9Hz	$2{\cdot}5\times10^{10}$Hz		
Polymethyl-methacrylate	3·12	2·76	2·60	—	0·0465	0·0140	0·0057	—	990	75
Cellulose nitrate 25% camphor	8·4	6·6	3·74	—	0·1	0·064	0·165	—	—	—
P.T.F.E.	2·1	2·1	2·1	2·08	<0·0003	<0·0002	0·00015	0·0006	1000–2000	66
P.V.C.	3·1	2·88	2·84	—	0·0185	0·016	0·0055	—	400	54
ORGANIC LIQUIDS										
Benzene	2·28	2·28	2·28	2·28	<0·0001	<0·0001	<0·0001	<0·0001	—	—
Ethyl Alcohol	—	24·5	6·5	—	—	0·090	0·250	—	—	—
Methyl Alcohol	—	31	23·9	—	—	0·20	0·64	—	—	—
Ethylene Glycol	—	41	12	—	—	0·030	1·00	—	—	—
Vaseline	2·16	2·16	2·16	—	0·0002	<0·0001	0·00066	—	—	—
WAXES										
Yellow bees wax	2·66	2·53	2·39	—	0·0140	0·0092	0·0075	—	—	45–64
Paraffin wax	2·25	2·25	2·25	2·2	<0·0002	<0·0002	0·0002	<0·0003	1060	36
RUBBERS										
Gutta-Percha	2·60	2·53	2·40	—	0·0004	0·0042	0·0060	—	—	—
Silicone-Rubber compound	3·35	3·20	3·13	—	0·0067	0·0030	0·0097	—	—	—
Filled Thiokol	2260	110	16	13·6	1·29	0·39	0·22	0·10	—	—
WOODS										
Balsa wood	1·4	1·37	1·22	—	0·0040	0·0120	0·100	—	—	—
Mahogany	2·40	2·25	1·88	1·6	0·0120	0·025	0·025	0·020	—	—
Poplar	1·79	1·75	1·50	1·4	0·0054	0·019	0·015	0·017	—	—
MISCELLANEOUS										
Mica	5·4	5·4	5·4	—	0·0006	0·0003	0·0003	—	3800–5600	—
Micalex	7·45	7·39	—	—	0·0019	0·0013	—	—	—	—
Sandy dry soil	2·91	2·59	2·55	—	0·08	0·017	0·0062	—	—	—
Distilled water	—	78·2	76·7	34	—	0·040	0·157	0·2650	—	—

Electric and Magnetic Quantities

DEFINITIONS, SYMBOLS AND CONVERSIONS

Term	*Definition, Units and Conversion*	*Abbreviation and Symbols*
Admittance	That property of a circuit (or circuit element) by virtue of which it allows alternating current to flow through it. It is the reciprocal of impedance and its unit is the mho.	Y $(G+jB)$
Capacitance	The ability of a circuit to store electricity. 1 farad requires 1 coulomb to raise its potential 1 volt. 1 farad $= 10^{-9}$ abfarads $= 10^{6}$ microfarads $= 10^{12}$ picofarads	C F μF pF
Coercive force	The demagnetising force required to reduce the magnetic flux density in a material from the remanent value to zero.	
Conductance	That property of a material by virtue of which it allows current to flow through it when a potential difference is applied across it. It is the reciprocal of resistance and its unit, the mho, is the reciprocal of the ohm. 1 mho $= 10^{-9}$ abmhos.	G g
Conductivity	The conductance between opposite faces of a centimeter cube of a material at a given temperature, in units of mhos per cubic centimetre.	mho cm.$^{-3}$ k
Current	The rate of flow of electricity. 1 ampere is that current which will deposit 0·001118 gm. of silver per second. 1 ampere = 0·1 abamperes.	amp. I i
Current Density	The current flowing across unit area. Typical units are amperes per square centimetre.	amp.cm.$^{-2}$
Electric Field	The space in the neighbourhood of a charged body, or of a varying magnetic field, throughout which an electric charge would experience a mechanical force.	E
Electric Flux	The quantity of electricity displaced across a given area in a dielectric. The total flux across a surface enclosing a charge is equal to the charge.	
Electric Flux density	The electric flux per unit area normal to the direction of the flux.	
Electric force, electric field strength	The mechanical force per unit charge experienced by a point charge at a point in an electric field. It is also the density of electric lines of force per unit area. Its unit is volt cm^{-1}.	$\mathscr{E}$

Term	*Definition, Units and Conversion*	*Abbreviations and Symbols*
Electric strength	The property of an insulating material which enables it to withstand electric stress, or the maximum stress it can withstand. Usually expressed in kilovolts per millimetre.	kV/mm.
Electromotive force, potential difference	The driving tendency behind an electric current. The potential difference across a conductor of resistance 1 ohm passing a current of 1 ampere is 1 volt. The e.m.f. of a battery is the potential difference between its terminals when no current flows through the battery. 1 volt = 10^8 abvolts.	e.m.f. E e V
Frequency	The number of cycles per second, the reciprocal of the period.	f
Impedance	That property of a circuit (or circuit element) which tends to oppose the flow of alternating current through it. Its unit is the ohm.	Z $(R + jX)$
Inductance	That property of a circuit which tends to oppose any change in current by setting up an opposing e.m.f. in that circuit (self induction) or in a neighbouring circuit (mutual induction). 1 henry is that inductance in which an induced e.m.f. of 1 volt is produced when the inducing current is changing at a rate of 1 ampere per second. 1 henry = 10^9 abhenrys.	L M
Line of electric force	A line drawn in an electric field such that its direction is everywhere that of the electric force.	
Line of magnetic force	A line drawn in a magnetic field such that its direction is everywhere that of the magnetic force.	
Magnetic field intensity or magnetising force	The force acting on a magnetic pole. I oersted exerts a force of 1 dyne on a unit magnetic pole. 1 oersted is also the number of lines of force intersecting 1 square centimetre normal to a unit magnetic field. Magnetising force is the space rate of variation in magnetic potential. 1 gilbert cm^{-1}. = 0·7958 amp turns cm^{-1}.	H
Magnetic flux	Through a given area is the product of the area and the magnetic field strength perpendicular to that area. 1 maxwell is the flux through 1 square centimetre normal to a field of 1 gauss. 1 maxwell = 1 line 1 weber = 10^8 maxwells. When a conductor cuts a magnetic field at a rate of 10^8 maxwells (1 weber) per second, 1 volt e.m.f. is induced in the conductor.	Φ ϕ

Term	*Definition, Units and Conversion*	*Abbreviations and Symbols*
Magnetic flux density	The magnetic flux per unit area. 1 gauss is a flux density of 1 maxwell per square centimetre.	B β
Magnetic moment	The ratio of the torque exerted in vacuum on a magnet to the magnetising force of the uniform field in which it is situated.	
Magnetomotive force, magnetic potential	At a point is the work done in bringing a unit positive pole from infinity to that point. 1 gilbert is that magnetic potential against which 1 erg of work is done when 1 unit magnetic pole is transferred. 4π gilberts = 10 ampere turns (1 ampere turn = 1·257 gilberts).	m.m.f. F
Permeability	That property of magnetic materials which modifies the action of magnetic poles placed therein. It is the reciprocal of reluctivity and equal to unity for a vacuum.	μ
Permittivity, dielectric constant	Of a material is the capacitance of a unit cube of that material. It is also defined by the equation $f = \frac{QQ'}{\epsilon r^2}$ where f is the force between two charges Q and Q' separated by a distance r in the material of permittivity ϵ.	κ ϵ
Potential (electric)	At a point is the potential difference between that point and earth.	
Potential gradient	At a point is the potential difference per unit length (measured in the direction in which it is a maximum). When an electric force is due to a potential difference it is equal to the potential gradient. Its unit is the volt cm^{-1}.	
Quantity of electricity	1 coulomb is the quantity of electricity transferred by a rate of current flow of 1 ampere per second. 1 coulomb is also the quantity of electricity on the positive plate of a condenser of 1 farad capacity when the electromotive force is 1 volt. 1 coulomb = 0·1 abcoulombs.	Q q
Reactance	The component of impedance in an a.c. circuit due to inductance or capacitance in the circuit. Its unit is the ohm.	X
Reluctance	That property of a magnetic circuit which determines the total magnetic flux in the circuit for a given applied magnetomotive force. When unit m.m.f. sets up unit flux in a circuit, that circuit has unit reluctance. It is expressed in oersteds if the m.m.f. is expressed in gilberts, and in rels if the m.m.f. is in ampere turns.	S

Term	*Definition, Units and Conversion*	*Abbreviations and Symbols*
Reluctivity, specific reluctance	Of a magnetic material is the reluctance between opposite faces of a centimeter cube of that material.	r
Remanence	The remanent magnetic flux density obtained in a material when the initial magnetisation reaches the saturation value of the material.	
Resistance	That property of a conductor which tends to oppose the flow of electric current through it. 1 ohm is the resistance of a column of mercury 106·300 cm. long of constant cross-sectional area and weighing 14·4521 gm. 1 ohm = 10^9 abohms.	Ω R r
Susceptance	The component of admittance in an a.c. circuit due to inductance or capacitance in the circuit. It is the reciprocal of reactance and its unit is the mho.	B

Properties of Semiconductors

Ge = germanium
Si = silicon
GaAs = gallium arsenide

	Ge	Si	GaAs
Atomic number	32	14	—
Atomic weight	72·60	28·06	144·63*
Atoms per cm³ (× 10²²)	4·42	4·99	4·43
Band gap (eV at 25°C.)	0·72	1·12	1·40
Density (gm./cm.³)	5·32	2·33	5·31
Dielectric constant	16	12	11
Electron diffusion constant (cm².sec at 25°C.)	100	47	180
Electron lattice mobility (cm.²/volt sec. at 25°C.)	3,900	1,900	7,000
Hole diffusion constant (cm.²/sec. at 25°C.)	50	13	11
Hole lattice mobility (cm.²/volt sec. at 25°C.)	1,900	500	450
Intrinsic resistivity (ohm cm. at 25°C.)	46	$2{\cdot}3\times10^5$	$3{\cdot}7\times10^8$
Linear coefficient of expansion ($\times 10^{-6}$ per °C.)	6·1	4·2	5·93
Magnetic susceptibility ($\times 10^6$)	−0·12	−0·13	—
Melting point (°C.)	936	1,420	1,238
Number of intrinsic electrons (per cm³. at 25°C.)	$2{\cdot}4\times10^{13}$	$1{\cdot}5\times10^{10}$	$1{\cdot}4\times10^6$
Specific heat (cal./gm.)	0·074	0·181	0·086
Temperature dependence of band gap ($\times 10^{-4}$ eV/°C.)	−4·1	−4·4	−4·5
Temperature dependence of electron lattice mobility	$T^{-1{\cdot}66}$	$T^{-2{\cdot}5}$	$\sim T^{-1}$
Temperature dependence of hole lattice mobility	$T^{-2{\cdot}33}$	$T^{-2{\cdot}7}$	$\sim T^{-2{\cdot}1}$
Thermal conductivity (cal./sec.cm.°C.)	0·14	0·20	0·12

*Molecular weight

General Terminology for Semiconductors

Semiconductor

(a) A monocrystalline substance of a basically extremely high degree of chemical purity, functioning as the host for minute amounts of impurities, introduced by one of a variety of specific processes in a manner to produce thin layers of minute differences in composition, with the result that the electrical characteristics in the direction vertical to the layers are fixed by interface phenomena at the boundary, or boundaries, between the layers.

(b) A polycrystalline substance prepared as a thin layer on a metal plate in such a manner that the electric characteristics in the direction vertical to the metal plate are fixed by the interface phenomena at the boundary between the layer and the metal plate.

n-type semiconductor

An extrinsic semiconductor in which the conduction-electron density exceeds the mobile hole density.

p-type semiconductor

An extrinsic semiconductor in which the mobile hole density exceeds the conduction-electron density.

I-type (intrinsic) Semiconductor

Nearly pure and ideal semiconductor in which the electron and hole densities are nearly equal under conditions of thermal equilibrium.

Semiconductor Device

A device whose essential characteristics are due to the flow of charge carriers within a semiconductor.

Semiconductor Diode

A two-terminal semiconductor device having an asymmetrical voltage-current characteristic.

Note: Unless otherwise qualified, this term usually means a device with the voltage-current characteristic typical of single p-n junction.

Varistor

A two-terminal semiconductor device having a non-linear but symmetric current-voltage characteristic.

Junction

A region of transition between semiconducting regions of different electrical properties.

P N Junction

A junction between p and n type regions in a semiconductor material.

Absolute Maximum Ratings

The values specified for "ratings", "maximum ratings", or "absolute maximum ratings" are based on the "absolute system" and are not to be exceeded under any service or test conditions. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired. It follows that a combination of absolute maximum ratings cannot normally be attained simultaneously. Unless otherwise specified, the voltage, current and power ratings are based on continuous d.c. power conditions at 25°C ambient temperature. For pulsed or other conditions of operation of similar nature, the current, voltage and power dissipation ratings are a function of time and duty cycles. In order not to exceed absolute ratings, the equipment designer has the responsibility of determining an average design value, for each rating, below the absolute value of that rating by a safety factor, so that the absolute values will never be exceeded under any conditions of supply-voltage variation, load variation or manufacturing variations in the equipment itself.

Thermal De-rating Factor

The factor by which the power dissipation rating must be reduced with increase of ambient or case temperature.

Thermal Resistance

Of a semiconductor device. The quotient of the temperature difference between two specified points or regions and the heat flow between these two points or regions under conditions of thermal equilibrium.

Note: For most cases the heat flow can be assumed to be equal to the power dissipation.

Ambient Temperature

The air temperature measured below a semiconductor device in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces.

Reference Point Temperature

The temperature measured at a specified point on the device.

Note: This point may, for example, be the mounting base, case or stud.

Cut-off Frequency

The frequency at which the modulus of a measured parameter has decreased to $1/\sqrt{2}$ of its mid frequency value.

Note: For a transistor, the cut-off frequency usually applies to the short-circuit small-signal forward current transfer ratio for either the common-base or common-emitter configuration.

Noise Factor

The noise factor is the ratio of the available signal-to-noise power ratio at the input, to the available signal-to-noise power ratio at the output of a device. The input noise temperature shall be related to 293°K.

Noise Figure

The noise factor expressed in decibels.

Terminology for Semiconductor Devices

Voltage-regulator Diode

A diode which develops across its terminals an essentially constant voltage throughout a specified current range.

Voltage-reference Diode

A diode which develops across its terminal a reference voltage of specified accuracy, when biased within a specified current range.

Tunnel Diode

A diode having a p-n junction in which the tunnel effect gives rise to negative differential conductance in a certain range of the forward direction of the current-voltage characteristic.

Transistor

A semiconductor device capable of providing power amplification and having three or more terminals.

Photo-transistor

A transistor utilizing the photo-electric effect.

Field-effect Transistor

A transistor in which the current flowing through a conduction channel is controlled by an electric field arising from a voltage applied on a gate electrode.

Junction-gate Field-effect Transistor

A field-effect transistor which uses one or more gate regions which form p-n junction(s) with the channel.

Insulated-gate Field-effect Transistor (I.G.F.E.T.)

A field-effect transistor with gate electrode(s) which is (are) electrically insulated from the channel.

Metal-oxide Semiconductor Field-effect Transistor (M.O.S.T.)

An insulated-gate field-effect transistor in which the insulating layer(s) between the gate electrode(s) and channel is (are) oxide material.

N-channel Field-effect Transistor

A field-effect transistor which has an n-type conductive channel.

P-channel Field-effect Transistor

A field-effect transistor which has a p-type conductive channel.

Deletion Type Field-effect Transistor

A field-effect transistor which has appreciable channel conductivity at zero gate to source voltage and whose channel conductivity may be increased or decreased according to the polarity of the gate to source voltage.

Enhancement Type Field-effect Transistor

A field-effect transistor which has substantially zero channel conductivity with zero gate to source voltage and whose channel may be made conductive by the application of a gate to source voltage of approrpiate polarity.

Triode Field-effect Transistor

A field-effect transistor having a gate region, a source region and a drain region.

Note: Where no confusion is possible, the term may be abbreviated to "field-effect triode".

Terminology for Microelectronics

Microelectronics

The concept of the construction and use of highly miniaturized electronic circuits.

Micro-circuit

A micro-electronic device, having a high equivalent circuit-element and/or component density which is considered as a single unit.

Note: A micro-circuit may be a micro-assembly or an integrated (micro-) circuit.

Integrated (micro-) Circuit

A micro-circuit in which a number of circuit elements are inseparably associated and electrically interconnected such that for the purposes of specification and testing, commerce and maintenance, it is considered indivisible.

Note 1: For this definition, a circuit element does not include envelope or external connection and is not specified or sold as a separate item.

Note 2: Where no misunderstanding is possible, the term Integrated Micro-circuit may be abbreviated to Integrated Circuit.

Note 3: Further qualifying adjectives may be used to describe the technique used in the manufacture of a specific integrated micro-circuit.

Examples of the use of qualifying adjectives:

Semiconductor monolithic integrated circuit
Semiconductor multi-chip integrated circuit
Thin film integrated circuit
Thick film integrated circuit
Hybrid integrated circuit.

Micro-assembly

A micro-circuit in which the various components and/or integrated micro-circuits are constructed separately and can be tested before being assembled and packaged.

Note 1: For this definition it is assumed that a component has external connections and possibly an envelope as well and that it can also be specified and sold as a separate item.

Note 2: Further qualifying adjectives may be used to describe the form of the components and/or the assembly technique used in the construction of the specified micro-assembly.

Examples of the use of qualifying adjectives:

Semiconductor multi-chip micro-assembly
Discrete component micro-assembly

Terminology for Integrated (micro-) Circuits

Digital (integrated) Circuit

A circuit which operates with digital variables at the input(s) and output(s) and which is characterised by the inter-relationships between the states of the digital variables at the input and output terminals.

Note: The digital variable may be voltage, or current, or impedance, etc.

Binary (digital) Circuit

A digital circuit in which the digital variable at each input or output terminal may take one of only two states.

Note: The pairs of ranges of values of the digital variable may, however, be different at different terminals.

Combinatorial (digital) Circuit

A digital circuit in which for each possible combination of the states of the digital variable at the input(s), there is one, and only one, combination of the states of the digital variable at the output(s).

Sequential (digital) Circuit

A digital circuit in which there exists at least one combination of the states of the digital variable at the input(s) for which there is more than one corresponding combination of the states of the digital variables at the output(s).

Note: These combinations at the outputs are detern ined by the previous electrical history (including internal memory, delay, etc.).

Monostable (binary digital) Circuit

A sequential circuit which has one stable state and which requires an appropriate excitation to remain in another defined state during a determined time interval.

Note 1: This time interval may be independent of the duration of the excitation.

Note 2: The stable state has an unlimited duration when no excitation is applied.

Bistable (binary digital) Circuit

A sequential circuit which has two internal states both of which are stable and which requires an appropriate excitation when in either state to cause a transition to the other state.

Multistable (binary digital) Circuit

A sequential circuit which has more than two internal states each of which is stable and which requires an appropriate excitation when in any state to cause a transition to another state.

Delay (binary digital) Circuit

A sequential circuit for which the changes in the states of the digital variable at the output(s) are delayed for a determined time with regard to the respective changes in the states of the digital variable at the input(s).

Note: The delay may or may not be the same for changes of the digital variable to each state.

Gate

A network having one or more inputs which opens or closes a channel according to the combination of stimuli applied to the input(s).

Positive—AND gate (Negative—OR gate)

A binary digital gate whose output is in the High state if, and only if all its imputs are in the High state.

Positive—OR gate (Negative—AND gate)

A binary digital gate whose output is in the Low state if, and only if all its imputs are in the Low state.

Positive—NAND gate (Negative—NOR gate)

A binary digital gate whose output is in the Low state if, and only if all its imputs are in the High state.

Positive—NOR gate (Negative—NAND gate)

A binary digital gate whose output is in the High state if, and only if all its inputs are in the Low state.

Analogue Integrated Circuit

A circuit for which a continuous relationship (either linear or non-linear) exists between its input(s) and output(s).

Terminology for Automation System/Engineering

PERIPHERAL EQUIPMENT (or 'Peripherals')	The various items of equipment which are connected to a computer to make up any particular system.
CENTRAL DATA PROCESSING SYSTEM	The assembly of equipment—including computers and peripherals—which form the electronic 'heart' of the complete scheme.
COMPUTER STORE (or Memory)	A vital part of a computer used to retain (or remember) operating data and instructions during computation processes.
DISC FILE STORE	One particular peripheral device used as an additional electronic memory for retaining data and operating instructions within the system.
SOFTWARE	A recognised name for computer programmes—the information having been prepared by 'programmers' and punched on to paper tape.
TAPE READER	The device to convert the information on the paper tape into electrical input signals to the computer.
DISPLAY 'BACK-UP'	The waveform generation and processing equipment connected between the display indicator units and the computer system.
'ON-LINE' OPERATION	The mode of operation in which the computing system is directly connected to the plant or process which is to be controlled.
'OFF-LINE' OPERATION	The mode of operation in which the computing system provides data to permit control or processing operations to be carried out but is *not* directly connected to the plant or process which is being controlled.
'REAL-TIME' OPERATION	The mode of operation where the computing system is required to provide data to control and/or monitor events at the instant they occur.
INTERFACE EQUIPMENT	Equipment interposed between two other equipments (or systems) to ensure compatibility of operation.

Squares, Cubes, Square Roots and Cube Roots

No	*Square*	*Cube*	*Square Root*	*Cube Root*	*No.*	*Square*	*Cube*	*Square Root*	*Cube Root*
$\frac{1}{8}$	·015	·0019	·353	·5	$6\frac{1}{4}$	39·062	244·140	2·500	1·84
$\frac{1}{4}$	·062	·0156	·500	·629	$6\frac{1}{2}$	42·250	274·625	2·549	1·86
$\frac{3}{8}$	·140	·0527	·612	·721	$6\frac{3}{4}$	45·562	307·546	2·598	1·88
$\frac{1}{2}$	·250	·1250	·707	·793	7	49	343	2·645	1·91
$\frac{5}{8}$	·390	·244	·790	·855	$7\frac{1}{4}$	52·562	381·078	2·692	1·93
$\frac{3}{4}$	·562	·421	·866	·908	$7\frac{1}{2}$	56·250	421·875	2·738	1·95
$\frac{7}{8}$	·765	·670	·935	·956	$7\frac{3}{4}$	60·062	465·484	2·783	1·97
1	1	1	1	1	8	64	512	2·828	2
$1\frac{1}{8}$	1·265	1·423	1·060	1·04	$8\frac{1}{4}$	68·062	561·515	2·872	2·02
$1\frac{1}{4}$	1·562	1·953	1·118	1·07	$8\frac{1}{2}$	72·250	614·125	2·915	2·04
$1\frac{3}{8}$	1·890	2·599	1·172	1·11	$8\frac{3}{4}$	76·562	669·921	2·958	2·06
$1\frac{1}{2}$	2·250	3·375	1·224	1·14	9	81	729	3	2·08
$1\frac{5}{8}$	2·641	4·291	1·274	1·17	$9\frac{1}{4}$	85·562	791·453	3·041	2·09
$1\frac{3}{4}$	3·062	5·359	1·322	1·20	$9\frac{1}{2}$	90·25	857·375	3·082	2·11
$1\frac{7}{8}$	3·515	6·591	1·369	1·23	$9\frac{3}{4}$	95·062	926·859	3·122	2·13
2	4	8	1·414	1·26	10	100	1000	3·162	2·15
$2\frac{1}{8}$	4·515	9·595	1·457	1·28	$10\frac{1}{4}$	105·062	1076·89	3·201	2·17
$2\frac{1}{4}$	5·062	11·390	1·500	1·30	$10\frac{1}{2}$	110·250	1157·625	3·240	2·18
$2\frac{3}{8}$	5·640	13·396	1·541	1·33	$10\frac{3}{4}$	115·562	1242·296	3·278	2·20
$2\frac{1}{2}$	6·250	15·625	1·581	1·35	11	121	1331	3·316	2·22
$2\frac{5}{8}$	6·890	18·088	1·620	1·37	$11\frac{1}{4}$	126·562	1423·828	3·354	2·24
$2\frac{3}{4}$	7·562	20·796	1·658	1.40	$11\frac{1}{2}$	132·250	1520·875	3·391	2·25
$2\frac{7}{8}$	8·265	23·763	1·695	1·42	$11\frac{3}{4}$	138·062	1622·234	3·427	2·27
3	9	27	1·732	1·44	12	144	1728	3·464	2·29
$3\frac{1}{8}$	9·765	30·517	1·767	1·46	$12\frac{1}{4}$	150·062	1838·265	3·500	2·31
$3\frac{1}{4}$	10·562	34·328	1·802	1·48	$12\frac{1}{2}$	156·250	1953·125	3·535	2·32
$3\frac{3}{8}$	11·390	38·443	1·837	1·50	$12\frac{3}{4}$	162·562	2072·672	3·572	2·34
$3\frac{1}{2}$	12·250	42·875	1·870	1·51	13	169	2197	3·606	2·35
$3\frac{5}{8}$	13·140	47·634	1·903	1·53	$13\frac{1}{4}$	175·562	2326.203	3·640	2·36
$3\frac{3}{4}$	14·062	52·734	1·936	1·55	$13\frac{1}{2}$	182·250	2460·375	3·675	2·38
$3\frac{7}{8}$	15·015	58·185	1·968	1·57	$13\frac{3}{4}$	189·062	2599·609	3·710	2·39
4	16	64	2	1·58	14	196	2744	3·742	2·41
$4\frac{1}{4}$	18·062	76·765	2·061	1·61	$14\frac{1}{4}$	203·062	2893·641	3·775	2·42
$4\frac{1}{2}$	20·250	91·125	2·121	1·65	$14\frac{1}{2}$	210·250	3048·625	3·815	2·44
$4\frac{3}{4}$	22·562	107·171	2·179	1·68	$14\frac{3}{4}$	217·562	3209·047	3·840	2·45
5	25	125	2·236	1·71	15	225	3375	3·873	2·47
$5\frac{1}{4}$	27·562	144·703	2·291	1·73	$15\frac{1}{4}$	232·562	3546·578	3·905	2·48
$5\frac{1}{2}$	30·250	166·375	2·345	1·76	$15\frac{1}{2}$	240·250	3726·875	3·932	2·49
$5\frac{3}{4}$	33·062	190·109	2·397	1·79	$15\frac{3}{4}$	248·062	3906·934	3·966	2·50
6	36	216	2·449	1·81	16	256	4096	4	2·52

Diameters, Circumferences and Areas of Circles

Dia.	*Circum.*	*Area*	*Dia.*	*Circum.*	*Area*	*Dia.*	*Circum.*	*Area*
$\frac{1}{32}$	·0982	·0008	$\frac{5}{8}$	17·671	24·850	$\frac{1}{2}$	58·119	268·80
$\frac{1}{16}$	·1963	·0031	$\frac{3}{4}$	18·064	25·967	$\frac{3}{4}$	58·905	276·12
$\frac{1}{8}$	·3927	·0122	$\frac{7}{8}$	18·457	27·108	19	59·690	283·52
$\frac{3}{16}$	·5890	·0276	6	18·849	28·274	$\frac{1}{4}$	60·475	291·04
$\frac{1}{4}$	·7854	·0490	$\frac{1}{4}$	19·635	30·679	$\frac{1}{2}$	61·261	298·64
$\frac{5}{16}$	·9817	·0767	$\frac{1}{2}$	20·420	33·183	$\frac{3}{4}$	62·046	306·35
$\frac{3}{8}$	1·1781	·1104	$\frac{3}{4}$	21·205	35·784	20	62·832	314·16
$\frac{7}{16}$	1·3744	·1503	7	21·991	38·484	$\frac{1}{4}$	63·617	322·06
$\frac{1}{2}$	1·5708	·1963	$\frac{1}{4}$	22·776	41·282	$\frac{1}{2}$	64·402	330·06
$\frac{9}{16}$	1·7671	·2485	$\frac{1}{2}$	23·562	44·178	$\frac{3}{4}$	65·188	338·16
$\frac{5}{8}$	1·9635	·3068	$\frac{3}{4}$	24·347	47·173	21	65·973	346·36
$\frac{11}{16}$	2·1598	·3712	8	25·132	50·265	$\frac{1}{4}$	66·759	354·66
$\frac{3}{4}$	2·3562	·4418	$\frac{1}{4}$	25·918	53·456	$\frac{1}{2}$	67·544	363·05
$\frac{13}{16}$	2·5525	·5185	$\frac{1}{2}$	26·703	56·745	$\frac{3}{4}$	68·329	371·54
$\frac{7}{8}$	2·7489	·6013	$\frac{3}{4}$	27·489	60·132	22	69·115	380·13
$\frac{15}{16}$	2·9452	·6903	9	28·274	63·617	$\frac{1}{4}$	69·900	388·82
1	3·1416	·7854	$\frac{1}{4}$	29·059	67·200	$\frac{1}{2}$	70·686	397·60
$\frac{1}{8}$	3·5343	·9940	$\frac{1}{2}$	29·845	70·882	$\frac{3}{4}$	71·471	406·49
$\frac{1}{4}$	3·9270	1·2271	$\frac{3}{4}$	30·630	74·662	23	72·256	415·47
$\frac{3}{8}$	4·3197	1·4848	10	31·416	78·540	$\frac{1}{4}$	73·042	424·56
$\frac{1}{2}$	4·7124	1·7671	$\frac{1}{4}$	32·201	82·516	$\frac{1}{2}$	73·827	433·73
$\frac{5}{8}$	5·1051	2·0739	$\frac{1}{2}$	32·986	86·590	$\frac{3}{4}$	74·613	443·01
$\frac{3}{4}$	5·4978	2·4052	$\frac{3}{4}$	33·772	90·762	24	75·398	452·39
$\frac{7}{8}$	5·8905	2·7611	11	34·558	95·033	$\frac{1}{2}$	76·969	471·43
2	6·2832	3·1416	$\frac{1}{4}$	35·343	99·402	25	78·540	490·87
$\frac{1}{8}$	6·6759	3·5465	$\frac{1}{2}$	36·128	103·86	$\frac{1}{2}$	80·110	510·70
$\frac{1}{4}$	7·0686	3·9760	$\frac{3}{4}$	36·913	108·43	26	81·681	530·93
$\frac{3}{8}$	7·4613	4·4302	12	37·699	113·09	$\frac{1}{2}$	83·252	551·54
$\frac{1}{2}$	7·8540	4.9087	$\frac{1}{4}$	38·484	117·86	27	84·823	572·55
$\frac{5}{8}$	8·2467	5·4119	$\frac{1}{2}$	39·270	122·71	$\frac{1}{2}$	86·394	593·95
$\frac{3}{4}$	8·6394	5·9395	$\frac{3}{4}$	40·055	127·68	28	87·964	615·75
$\frac{7}{8}$	9·0321	6·4918	13	40·840	132·73	$\frac{1}{2}$	89·535	637·94
3	9·4248	7·0686	$\frac{1}{4}$	41·626	137·89	29	91·106	660·52
$\frac{1}{8}$	9·8175	7·6699	$\frac{1}{2}$	42·411	143·13	$\frac{1}{2}$	92·677	683·49
$\frac{1}{4}$	10·210	8·2957	$\frac{3}{4}$	43·197	148·49	30	94·248	707·86
$\frac{3}{8}$	10·602	8·9462	14	43·982	153·93	$\frac{1}{2}$	95·818	730·61
$\frac{1}{2}$	10·995	9·6211	$\frac{1}{4}$	44·767	159·48	31	97·389	754·76
$\frac{5}{8}$	11·388	10·320	$\frac{1}{2}$	45·553	165·13	$\frac{1}{2}$	98·968	779·31
$\frac{3}{4}$	11·781	11·044	$\frac{3}{4}$	46·338	170·87	32	100·53	804·24
$\frac{7}{8}$	12·173	11·793	15	47·124	176·71	$\frac{1}{2}$	102·10	829·57
4	12·566	12·566	$\frac{1}{4}$	47.909	182·65	33	103·67	855·30
$\frac{1}{8}$	12·959	13·364	$\frac{1}{2}$	48·694	188·69	$\frac{1}{2}$	105·24	881·41
$\frac{1}{4}$	13·351	14·186	$\frac{3}{4}$	49·480	194·83	34	106·81	907·92
$\frac{3}{8}$	13·744	15·033	16	50·265	201·06	$\frac{1}{2}$	108·38	934·82
$\frac{1}{2}$	14·137	15·904	$\frac{1}{4}$	51·051	207·39	35	109·95	966·11
$\frac{5}{8}$	14·529	16·800	$\frac{1}{2}$	51·836	213·82	$\frac{1}{2}$	111·52	989·80
$\frac{3}{4}$	14·922	17·720	$\frac{3}{4}$	52·621	220·35	36	113·09	1017·9
$\frac{7}{8}$	15·315	18·665	17	53·407	226·98	$\frac{1}{2}$	114·66	1046·3
5	15·708	19·635	$\frac{1}{4}$	54·192	233·70	37	116·23	1075·2
$\frac{1}{8}$	16·100	20·629	$\frac{1}{2}$	54·977	240·52	$\frac{1}{2}$	117·81	1104·5
$\frac{1}{4}$	16·493	21·647	$\frac{3}{4}$	55·763	247·45	38	119·39	1134·1
$\frac{3}{8}$	16·886	22·690	18	56·548	254·46	39	122·52	1194·6
$\frac{1}{2}$	17·278	23·758	$\frac{1}{4}$	57·334	261·59	40	125·66	1256·6

Logarithms

	0	1	2	3	4	5	6	7	8	9	1 3	5	7 9
10	0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4 12	21	29 37
11	0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4 11	19	26 34
12	0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3 10	17	24 31
13	1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3 10	16	23 29
14	1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3 9	15	21 27
15	1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3 8	14	20 25
16	2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3 8	13	18 24
17	2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2 7	12	17 22
18	2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2 7	12	16 21
19	2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2 7	11	16 20
20	3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2 6	11	15 19
21	3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2 6	10	14 18
22	3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2 6	10	14 17
23	3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2 6	9	13 17
24	3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2 5	9	12 16
25	3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2 5	9	12 15
26	4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2 5	8	11 15
27	4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2 5	8	11 14
28	4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2 5	8	11 14
29	4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1 4	7	10 13
30	4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1 4	7	10 13
31	4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1 4	7	10 12
32	5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1 4	7	9 12
33	5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1 4	6	9 12
34	5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1 4	6	9 11
35	5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1 4	6	9 11
36	5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1 4	6	8 11
37	5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1 3	6	8 10
38	5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1 3	6	8 10
39	5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1 3	5	8 10
40	6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1 3	5	8 10
41	6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1 3	5	7 9
42	6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1 3	5	7 9
43	6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1 3	5	7 9
44	6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1 3	5	7 9
45	6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1 3	5	7 9
46	6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1 3	5	7 8
47	6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1 3	5	6 8
48	6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1 3	4	6 8
49	6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1 3	4	6 8
50	6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1 3	4	6 8
51	7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1 3	4	6 8
52	7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1 2	4	6 7
53	7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1 2	4	6 7
54	7324	7332	7340	7348	7356	7364	7372	7380	3788	7396	1 2	4	6 7

Note: Differences 2, 4, 6, 8 obtained by interpolation

	0	1	2	3	4	5	6	7	8	9	1	3	5	7	9
55	7404	7412	7419	7427	7435	7443	7451	7459	7466	7474	1	2	4	5	7
56	7482	7490	7497	7505	7513	7520	7528	7536	7543	7551	1	2	4	5	7
57	7559	7566	7574	7582	7589	7597	7604	7612	7619	7627	1	2	4	5	7
58	7634	7642	7649	7657	7664	7672	7679	7686	7694	7701	1	2	4	5	7
59	7709	7716	7723	7731	7738	7745	7752	7760	7767	7774	1	2	4	5	7
60	7782	7789	7796	7803	7810	7818	7825	7832	7839	7846	1	2	4	5	6
61	7853	7860	7868	7875	7882	7889	7896	7903	7910	7917	1	2	4	5	6
62	7924	7931	7938	7945	7952	7959	7966	7973	7980	7987	1	2	3	5	6
63	7993	8000	8007	8014	8021	8028	8035	8041	8048	8055	1	2	3	5	6
64	8062	8069	8075	8082	8089	8096	8102	8109	8116	8122	1	2	3	5	6
65	8129	8136	8142	8149	8156	8162	8169	8176	8182	8189	1	2	3	5	6
66	8195	8202	8209	8215	8222	8228	8235	8241	8248	8254	1	2	3	5	6
67	8261	8267	8274	8280	8287	8293	8299	8306	8312	8319	1	2	3	5	6
68	8325	8331	8338	8344	8351	8357	8363	8370	8376	8382	1	2	3	4	6
69	8388	8395	8401	8407	8414	8420	8426	8432	8439	8445	1	2	3	4	6
70	8451	8457	8463	8470	8476	8482	8488	8494	8500	8506	1	2	3	4	6
71	8513	8519	8525	8531	8537	8543	8549	8555	8561	8567	1	2	3	4	5
72	8573	8579	8585	8591	8597	8603	8609	8615	8621	8627	1	2	3	4	5
73	8633	8639	8645	8651	8657	8663	8669	8675	8681	8686	1	2	3	4	5
74	8692	8698	8704	8710	8716	8722	8727	8733	8739	8745	1	2	3	4	5
75	8751	8756	8762	8768	8774	8779	8785	8791	8797	8802	1	2	3	4	5
76	8808	8814	8820	8825	8831	8837	8842	8848	8854	8859	1	2	3	4	5
77	8865	8871	8876	8882	8887	8893	8899	8904	8910	8915	1	2	3	4	5
78	8921	8927	8932	8938	8943	8949	8954	8960	8965	8971	1	2	3	4	5
79	8976	8982	8987	8993	8998	9004	9009	9015	9020	9025	1	2	3	4	5
80	9031	9036	9042	9047	9053	9058	9063	9069	9074	9079	1	2	3	4	5
81	9085	9090	9096	9101	9106	9112	9117	9122	9128	9133	1	2	3	4	5
82	9138	9143	9149	9154	9159	9165	9170	9175	9180	9186	1	2	3	4	5
83	9191	9196	9201	9206	9212	9217	9222	9227	9232	9238	1	2	3	4	5
84	9243	9248	9253	9258	9263	9269	9274	9279	9284	9289	1	2	3	4	5
85	9294	9299	9304	9309	9315	9320	9325	9330	9335	9340	1	2	3	4	5
86	9345	9350	9355	9360	9365	9370	9375	9380	9385	9390	1	2	3	4	5
87	9395	9400	9405	9410	9415	9420	9425	9430	9435	9440	0	1	2	3	4
88	9445	9450	9455	9460	9465	9469	9474	9479	9484	9489	0	1	2	3	4
89	9494	9499	9504	9509	9513	9518	9523	9528	9533	9538	0	1	2	3	4
90	9542	9547	9552	9557	9562	9566	9571	9576	9581	9586	0	1	2	3	4
91	9590	9595	9600	9605	9609	9614	9619	9624	9628	9633	0	1	2	3	4
92	9638	9643	9647	9652	9657	9661	9666	9671	9675	9680	0	1	2	3	4
93	9685	9689	9694	9699	9703	9708	9713	9717	9722	9727	0	1	2	3	4
94	9731	9736	9741	9745	9750	9754	9759	9763	9768	9773	0	1	2	3	4
95	9777	9782	9786	9791	9795	9800	9805	9809	9814	9818	0	1	2	3	4
96	9823	9827	9832	9836	9841	9845	9850	9854	9859	9863	0	1	2	3	4
97	9868	9872	9877	9881	9886	9890	9894	9899	9903	9908	0	1	2	3	4
98	9912	9917	9921	9926	9930	9934	9939	9943	9948	9952	0	1	2	3	4
99	9956	9961	9965	9969	9974	9978	9983	9987	9991	9996	0	1	2	3	4

Note: Common logarithms = hyperbolic logarithms × 0·43429.

Antilogarithms

	0	1	2	3	4	5	6	7	8	9	1	3	5	7	9
·00	1000	1002	1005	1007	1009	1012	1014	1016	1019	1021	0	1	1	2	2
·01	1023	1026	1028	1030	1033	1035	1038	1040	1042	1045	0	1	1	2	2
·02	1047	1050	1052	1054	1057	1059	1062	1064	1067	1069	0	1	1	2	2
·03	1072	1074	1076	1079	1081	1084	1086	1089	1091	1094	0	1	1	2	2
·04	1096	1099	1102	1104	1107	1109	1112	1114	1117	1119	0	1	1	2	2
·05	1122	1125	1127	1130	1132	1135	1138	1140	1143	1146	0	1	1	2	2
·06	1148	1151	1153	1156	1159	1161	1164	1167	1169	1172	0	1	1	2	2
·07	1175	1178	1180	1183	1186	1189	1191	1194	1197	1199	0	1	1	2	2
·08	1202	1205	1208	1211	1213	1216	1219	1222	1225	1227	0	1	1	2	3
·09	1230	1233	1236	1239	1242	1245	1247	1250	1253	1256	0	1	1	2	3
·10	1259	1262	1265	1268	1271	1274	1276	1279	1282	1285	0	1	1	2	3
·11	1288	1291	1294	1297	1300	1303	1306	1309	1312	1315	0	1	2	2	3
.12	1318	1321	1324	1327	1330	1334	1337	1340	1343	1346	0	1	2	2	3
·13	1349	1352	1355	1358	1361	1365	1368	1371	1374	1377	0	1	2	2	3
·14	1380	1384	1387	1390	1393	1396	1400	1403	1406	1409	0	1	2	2	3
·15	1413	1416	1419	1422	1426	1429	1432	1435	1439	1442	0	1	2	2	3
·16	1445	1449	1452	1455	1459	1462	1466	1469	1472	1476	0	1	2	2	3
·17	1479	1483	1486	1489	1493	1496	1500	1503	1507	1510	0	1	2	2	3
·18	1514	1517	1521	1524	1528	1531	1535	1538	1542	1545	0	1	2	2	3
·19	1549	1552	1556	1560	1563	1567	1570	1574	1578	1581	0	1	2	3	3
·20	1585	1589	1592	1596	1600	1603	1607	1611	1614	1618	0	1	2	3	3
·21	1622	1626	1629	1633	1637	1641	1644	1648	1652	1656	0	1	2	3	3
·22	1660	1663	1667	1671	1675	1679	1683	1687	1690	1694	0	1	2	3	3
·23	1698	1702	1706	1710	1714	1718	1722	1726	1730	1734	0	1	2	3	4
·24	1738	1742	1746	1750	1754	1758	1762	1766	1770	1774	0	1	2	3	4
·25	1778	1782	1786	1791	1795	1799	1803	1807	1811	1816	0	1	2	3	4
·26	1820	1824	1828	1832	1837	1841	1845	1849	1854	1858	0	1	2	3	4
·27	1862	1866	1871	1875	1879	1884	1888	1892	1897	1901	0	1	2	3	4
·28	1905	1910	1914	1919	1923	1928	1932	1936	1941	1945	0	1	2	3	4
·29	1950	1954	1959	1963	1968	1972	1977	1982	1986	1991	0	1	2	3	4
·30	1995	2000	2004	2009	2014	2018	2023	2028	2032	2037	0	1	2	3	4
·31	2042	2046	2051	2056	2061	2065	2070	2075	2080	2084	0	1	2	3	4
·32	2089	2094	2099	2104	2109	2113	2118	2123	2128	2133	0	1	2	3	4
·33	2138	2143	2148	2153	2158	2163	2168	2173	2178	2183	0	1	2	3	4
·34	2188	2193	2198	2203	2208	2213	2218	2223	2228	2234	1	2	3	4	5
·35	2239	2244	2249	2254	2259	2265	2270	2275	2280	2286	1	2	3	4	5
·36	2291	2296	2301	2307	2312	2317	2323	2328	2333	2339	1	2	3	4	5
·37	2344	2350	2355	2360	2366	2371	2377	2382	2388	2393	1	2	3	4	5
·38	2399	2404	2410	2415	2421	2427	2432	2438	2443	2449	1	2	3	4	5
·39	2455	2460	2466	2472	2477	2483	2489	2495	2500	2506	1	2	3	4	5
·40	2512	2518	2523	2529	2535	2541	2547	2553	2559	2564	1	2	3	4	5
·41	2570	2576	2582	2588	2594	2600	2606	2612	2618	2624	1	2	3	4	5
·42	2630	2636	2642	2649	2655	2661	2667	2673	2679	2685	1	2	3	4	6
·43	2692	2698	2704	2710	2716	2723	2729	2735	2742	2748	1	2	3	4	6
·44	2754	2761	2767	2773	2780	2786	2793	2799	2805	2812	1	2	3	4	6
·45	2818	2825	2831	2838	2844	2851	2858	2864	2871	2877	1	2	3	5	6
·46	2884	2891	2897	2904	2911	2917	2924	2931	2938	2944	1	2	3	5	6
·47	2951	2958	2965	2972	2979	2985	2992	2999	3006	3013	1	2	3	5	6
·48	3020	3027	3034	3041	3048	3055	3062	3069	3076	3083	1	2	4	5	6
·49	3090	3097	3105	3112	3119	3126	3133	3141	3148	3155	1	2	4	5	6

Note: Differences, 2, 4, 8 obtained by interpolation.

	0	1	2	3	4	5	6	7	8	9	1	3	5	7	9
·50	3162	3170	3177	3184	3192	3199	3206	3214	3221	3228	1	2	4	5	7
·51	3236	3243	3251	3258	3266	3273	3281	3289	3296	3304	1	2	4	5	7
·52	3311	3319	3327	3334	3342	3350	3357	3365	3373	3381	1	2	4	5	7
·53	3388	3396	3404	3412	3420	3428	3436	3443	3451	3459	1	2	4	6	7
·54	3467	3475	3483	3491	3499	3508	3516	3524	3532	3540	1	2	4	6	7
·55	3548	3556	3565	3573	3581	3589	3597	3606	3614	3622	1	2	4	6	7
·56	3631	3639	3648	3656	3664	3673	3681	3690	3698	3707	1	3	4	6	8
·57	3715	3724	3733	3741	3750	3758	3767	3776	3784	3793	1	3	4	6	8
·58	3802	3811	3819	3828	3837	3846	3855	3864	3873	3882	1	3	4	6	8
·59	3890	3899	3908	3917	3926	3936	3945	3954	3963	3972	1	3	5	6	8
·60	3981	3990	3999	4009	4018	4027	4036	4046	4055	4064	1	3	5	6	8
·61	4074	4083	4093	4102	4111	4121	4130	4140	4150	4159	1	3	5	7	9
·62	4169	4178	4188	4198	4207	4217	4227	4236	4246	4256	1	3	5	7	9
·63	4266	4276	4285	4295	4305	4315	4325	4335	4345	4355	1	3	5	7	9
·64	4365	4375	4385	4395	4406	4416	4426	4436	4446	4457	1	3	5	7	9
·65	4467	4477	4487	4498	4508	4519	4529	4539	4550	4560	1	3	5	7	9
·66	4571	4581	4592	4603	4613	4624	4634	4645	4656	4667	1	3	5	7	10
·67	4677	4688	4699	4710	4721	4732	4742	4753	4764	4775	1	3	5	8	10
·68	4786	4797	4808	4819	4831	4842	4853	4864	4875	4887	1	3	6	8	10
·69	4898	4909	4920	4932	4943	4955	4966	4977	4989	5000	1	3	6	8	10
·70	5012	5023	5035	5047	5058	5070	5082	5093	5105	5117	1	4	6	8	11
·71	5129	5140	5152	5164	5176	5188	5200	5212	5224	5236	1	4	6	8	11
·72	5248	5260	5272	5284	5297	5309	5321	5333	5346	5358	1	4	6	9	11
·73	5370	5383	5395	5408	5420	5433	5445	5458	5470	5483	1	4	6	9	11
·74	5495	5508	5521	5534	5546	5559	5572	5585	5598	5610	1	4	6	9	12
·75	5623	5636	5649	5662	5675	5689	5702	5715	5728	5741	1	4	7	9	12
·76	5754	5768	5781	5794	5808	5821	5834	5848	5861	5875	1	4	7	9	12
·77	5888	5902	5916	5929	5943	5957	5970	5984	5998	6012	1	4	7	10	12
·78	6026	6039	6053	6067	6081	6095	6109	6124	6138	6152	1	4	7	10	13
·79	6166	6180	6194	6209	6223	6237	6252	6266	6281	6295	1	4	7	10	13
·80	6310	6324	6339	6353	6368	6383	6397	6412	6427	6442	1	4	7	10	13
·81	6457	6471	6486	6501	6516	6531	6546	6561	6577	6592	2	5	8	11	14
·82	6607	6622	6637	6653	6668	6683	6699	6714	6730	6745	2	5	8	11	14
·83	6761	6776	6792	6808	6823	6839	6855	6871	6887	6902	2	5	8	11	14
·84	6918	6934	6950	6966	6982	6998	7015	7031	7047	7063	2	5	8	11	15
·85	7079	7096	7112	7129	7145	7161	7178	7194	7211	7228	2	5	8	12	15
·86	7244	7261	7278	7295	7311	7328	7345	7362	7379	7396	2	5	8	12	15
·87	7413	7430	7447	7464	7482	7499	7516	7534	7551	7568	2	5	9	12	16
·88	7586	7603	7621	7638	7656	7674	7691	7709	7727	7745	2	5	9	12	16
·89	7762	7780	7798	7816	7834	7852	7870	7889	7907	7925	2	5	9	13	16
·90	7943	7962	7980	7998	8017	8035	8054	8072	8091	8110	2	6	9	13	17
·91	8128	8147	8166	8185	8204	8222	8241	8260	8279	8299	2	6	9	13	17
·92	8318	8337	8356	8375	8395	8414	8433	8453	8472	8492	2	6	10	14	17
·93	8511	8531	8551	8570	8590	8610	8630	8650	8670	8690	2	6	10	14	18
·94	8710	8730	8750	8770	8790	8810	8831	8851	8872	8892	2	6	10	14	18
·95	8913	8933	8954	8974	8995	9016	9036	9057	9078	9099	2	6	10	15	19
·96	9120	9141	9162	9183	9204	9226	9247	9268	9290	9311	2	6	11	15	19
·97	9333	9354	9376	9397	9419	9441	9462	9484	9506	9528	2	7	11	15	20
·98	9550	9572	9594	9616	9638	9661	9683	9705	9727	9750	2	7	11	16	20
·99	9772	9795	9817	9840	9863	9886	9908	9931	9954	9977	2	7	11	16	20

Note: Hyperbolic logarithms = 2·3026 × common logarithms.

Degrees—Radians

Degrees	Radians	Degrees	Radians	Degrees	Radians
0° 00′	0·0000	10° 00′	0·1745	20° 00′	0·3491
10	·0029	10	·1774	10	·3520
20	·0058	20	·1804	20	·3549
30	·0087	30	·1833	30	·3578
40	·0116	40	·1862	40	·3607
50	·0145	50	·1891	50	·3636
1° 00′	·0175	11° 00′	·1920	21° 00	·3665
10	·0204	10	·1949	10	·3694
20	·0233	20	·1978	20	·3723
30	·0262	30	·2007	30	·3752
40	·0291	40	·2036	40	·3782
50	·0320	50	·2065	50	·3811
2° 00′	·0349	12° 00′	·2094	22° 00′	·3840
10	·0378	10	·2123	10	·3869
20	·0407	20	·2153	20	·3896
30	·0436	30	·2182	30	·3927
40	·0465	40	·2211	40	·3956
50	·0495	50	·2240	50	·3985
3° 00′	·0524	13° 00′	·2269	23° 00	·4014
10	·0553	10	·2298	10	·4043
20	·0582	20	·2327	20	·4072
30	·0611	30	·2356	30	·4102
40	·0640	40	·2385	40	·4131
50	·0669	50	·2414	50	·4160
4° 00′	·0698	14° 00′	·2443	24° 00′	·4189
10	·0727	10	·2473	10	·4218
20	·0756	20	·2502	20	·4247
30	·0785	30	·2531	30	·4276
40	·0814	40	·2560	40	·4305
50	·0844	50	·2589	50	·4334
5° 00′	·0873	15° 00′	·2618	25° 00′	·4363
10	·0902	10	·2647	10	·4392
20	·0931	20	·2676	20	·4422
30	·0960	30	·2705	30	·4451
40	·0989	40	·2734	40	·4480
50	·1018	50	·2763	50	·4509
6° 00′	·1047	16° 00′	·2793	26° 00′	·4538
10	·1076	10	·2822	10	·4567
20	·1105	20	·2851	20	·4596
30	.1134	30	·2880	30	·4625
40	·1164	40	·2909	40	·4654
50	·1193	50	·2938	50	·4683
7° 00′	·1222	17° 00′	·2967	27° 00′	·4712
10	·1251	10	·2996	10	·4741
20	·1280	20	·3025	20	·4771
30	·1309	30	·3054	30	·4800
40	·1338	40	·3083	40	·4829
50	·1367	50	·3113	50	·4858
8° 00′	·1396	18° 00′	·3142	28° 00′	·4887
10	·1425	10	·3171	10	·4196
20	·1454	20	·3200	20	·4945
30	·1484	30	.3229	30	·4974
40	·1523	40	·3258	40	·5003
50	·1542	50	·3287	50	·5032
9° 00′	·1571	19° 00′	·3316	29° 00′	·5061
10	·1600	10	·3345	10	·5091
20	·1629	20	·3374	20	·5120
30	·1658	30	·3403	30	·5149
40	·1687	40	·3432	40	·5178
50	·1716	50	·3462	50	·5207

Degrees—Radians

Degrees	Radians	Degrees	Radians	Degrees	Radians
30° 00′	0·5236	40° 00′	0·6981	50° 00′	0·8727
10	·5265	10	·7010	10	·8756
20	·5294	20	·7039	20	·8785
30	·5323	30	·7069	30	·8814
40	·5352	40	·7098	40	·8843
50	·5381	50	·7127	50	·8872
31° 00′	·5411	41° 00′	·7156	51° 00′	·8901
10	·5440	10	·7185	10	·8930
20	·5469	20	·7214	20	·8959
30	·5498	30	·7243	30	·8988
40	·5527	40	·7272	40	·9015
50	·5556	50	·7301	50	·9047
32° 00′	·5585	42° 00′	·7330	52° 00′	·9076
10	·5614	10	·7359	10	·9105
20	·5643	20	·7389	20	·9134
30	·5672	30	·7418	30	·9163
40	·5701	40	·7447	40	·9192
50	·5730	50	·7476	50	·9221
33° 00′	·5760	43° 00′	·7505	53° 00′	·9250
10	·5789	10	·7534	10	·9279
20	·5818	20	·7563	20	·9308
30	·5847	30	·7592	30	·9338
40	·5876	40	·7621	40	·9367
50	·5905	50	·7650	50	·9396
34° 00′	·5934	44° 00′	·7679	54° 00′	·9425
10	·5963	10	·7709	10	·9454
20	·5992	20	·7738	20	·9483
30	·6021	30	·7767	30	·9512
40	·6050	40	·7796	40	·9541
50	·6080	50	·7825	50	·9570
35° 00′	·6109	45° 00′	·7854	55° 00′	·9599
10	·6138	10	·7883	10	·9628
20	·6167	20	·7912	20	·9657
30	·6196	30	·7941	30	·9687
40	·6225	40	·7970	40	·9716
50	·6254	50	·7999	50	·9745
36° 00′	·6283	46° 00′	·8029	56° 00′	·9774
10	·6312	10	·8058	10	·9803
20	·6341	20	·8087	20	·9832
30	·6370	30	·8116	30	·9861
40	·6400	40	·8145	40	·9890
50	·6429	50	·8174	50	·9919
37° 00′	·6458	47° 00′	·8203	57° 00′	0·9948
10	·6487	10	·8232	10	0·9977
20	·6516	20	·8261	20	1·0007
30	·6545	30	·8290	30	1·0036
40	·6574	40	·8319	40	1·0065
50	·6603	50	·8348	50	1·0094
38° 00′	·6632	48° 00′	·8378	58° 00′	1·0123
10	·6661	10	·8407	10	1·0152
20	·6690	20	·8436	20	1·0181
30	·6720	30	·8465	30	1·0210
40	·6749	40	·8494	40	1·0239
50	·6778	50	·8523	50	1·0268
39° 00′	·6807	49° 00′	·8552	59° 00′	1·0297
10	·6836	10	·8581	10	1·0327
20	·6865	20	·8610	20	1·0356
30	·6894	30	·8639	30	1·0385
40	·6923	40	·8668	40	1·0414
50	·6952	50	·8698	50	1·0443

Degrees—Radians

Degrees	Radians	Degrees	Radians	Degrees	Radians
60° 00′	1·0472	70° 00′	1·2217	80° 00′	1·3963
10	1·0501	10	1·2246	10	1·3992
20	1·0530	20	1·2275	20	1·4021
30	1·0559	30	1·2305	30	1·4050
40	1·0588	40	1·2334	40	1·4079
50	1·0617	50	1·2363	50	1·4108
61° 00′	1·0647	71° 00′	1·2392	81° 00′	1·4137
10	1·0676	10	1·2421	10	1·4166
20	1·0705	20	1·2450	20	1·4195
30	1·0734	30	1·2479	30	1·4224
40	1·0763	40	1·2508	40	1·4254
50	1·0792	50	1·2537	50	1·4283
62° 00′	1·0821	72° 00′	1·2566	82° 00′	1·4312
10	1·0850	10	1·2595	10	1·4341
20	1·0879	20	1·2625	20	1·4370
30	1·0908	30	1·2654	30	1·4399
40	1·0937	40	1·2683	40	1·4428
50	1·0966	50	1·2712	50	1·4457
63° 00′	1·0996	73° 00′	1·2741	83° 00′	1·4486
10	1·1025	10	1·2770	10	1·4515
20	1·1054	20	1·2799	20	1·4544
30	1·1083	30	1·2828	30	1·4573
40	1·1112	40	1·2857	40	1·4603
50	1·1141	50	1·2886	50	1·4632
64° 00′	1·1170	74° 00′	1·2915	84° 00′	1·4661
10	1·1199	10	1·2945	10	1·4690
20	1·1228	20	1·2974	20	1·4719
30	1·1257	30	1·3003	30	1·4748
40	1·1286	40	1·3032	40	1·4777
50	1·1316	50	1·3061	50	1·4806
65° 00′	1·1345	75° 00′	1·3090	85° 00′	1·4835
10	1·1374	10	1·3119	10	1·4864
20	1·1403	20	1·3148	20	1·4893
30	1·1432	30	1·3177	30	1·4923
40	1·1461	40	1·3206	40	1·4952
50	1·1490	50	1·3235	50	1·4981
66° 00′	1·1519	76° 00′	1·3265	86° 00′	1·5010
10	1·1548	10	1·3294	10	1·5039
20	1·1577	20	1·3323	20	1·5068
30	1·1606	30	1·3352	30	1·5097
40	1·1636	40	1·3381	40	1·5126
50	1·1665	50	1·3410	50	1·5155
67° 00′	1·1694	77° 00′	1·3439	87° 00′	1·5184
10	1·1723	10	1·3468	10	1·5213
20	1·1752	20	1·3497	20	1·5243
30	1·1781	30	1·3526	30	1·5272
40	1·1810	40	1·3555	40	1·5301
50	1·1839	50	1·3584	50	1·5330
68° 00′	1·1868	78° 00′	1·3614	88° 00′	1·5359
10	1·1897	10	1·3643	10	1·5388
20	1·1926	20	1·3672	20	1·5417
30	1·1956	30	1·3701	30	1·5446
40	1·1985	40	1·3730	40	1·5475
50	1·2014	50	1·3759	50	1·5504
69° 00′	1·2043	79° 00′	1·3788	89° 00′	1·5533
10	1·2072	10	1·3817	10	1·5563
20	1·2101	20	1·3846	20	1·5592
30	1·2130	30	1·3875	30	1·5621
40	1·2159	40	1·3904	40	1·5650
50	1·2188	50	1·3934	50	1·5679
				90° 00′	1·5708

Exponential and Hyperbolic Functions

Radians							
x	e^x	e^{-x}	*cosh x.*	*sinh x.*	*tanh x*	*log. cosh x.*	*log. sinh x.*
·1	1·1052	·9048	1·0050	·1002	·0997	·0022	1·0007
·2	1·2214	·8187	1·0201	·2013	·1974	·0086	1·3039
·3	1·3499	·7408	1·0453	·3045	·2913	·0193	1·4836
·4	1·4918	·6703	1·0811	·4108	·3799	·0339	1·6136
·5	1·6487	·6065	1·1276	·5211	·4621	·0522	1·7169
·6	1·8221	·5488	1·1855	·6367	·5370	·0739	1·8039
·7	2·0138	·4966	1·2552	·7586	·6044	·0987	1·8800
·8	2·2255	·4493	1·3374	·8881	·6640	·1263	1·9485
·9	2·4596	·4066	1·4331	1·0265	·7163	·1563	0·0114
1·0	2·7183	·3679	1·5431	1·1752	·7616	·1884	0·0701
1·1	3·0042	·3329	1·6685	1·3357	·8005	·2223	0·1257
1·2	3·3201	·3012	1·8107	1·5095	·8337	·2578	0·1788
1·3	3·6698	·2725	1·9709	1·6984	·8617	·2947	0·2300
1·4	4·0552	·2466	2·1509	1·9043	·8854	·3326	0·2797
1·5	4·4817	·2231	2·3524	2·1293	·9051	·3715	0·3282
1·6	4·9530	·2019	2·5775	2·3756	·9217	·4112	0·3758
1·7	5·4739	·1827	2·8283	2·6456	·9354	·4515	0·4225
1·8	6·0496	·1653	3·1075	2·9422	·9468	·4924	0·4687
1·9	6·6859	·1496	3·4177	3·2682	·9563	·5337	0·5143
2·0	7·3891	·1353	3·7622	3·6269	·9640	·5754	0·5595
2·1	8·1662	·1225	4·1443	4·0219	·9704	·6175	0·6044
2·2	9·0251	·1108	4·5679	4·4571	·9758	·6597	0·6491
2·3	9·9742	·1003	5·0372	4·9370	·9801	·7022	0·6935
2·4	11·0232	·0907	5·5570	5·4662	·9837	·7448	0·7377
2·5	12·1825	·0821	6·1323	6·0502	·9866	·7876	0·7818
2·6	13·4638	·0743	6·7690	6·6947	·9890	·8305	0·8257
2·7	14·8797	·0672	7·4735	7·4063	·9910	·8735	0·8696
2·8	16·4446	·0608	8·2527	8·1919	·9926	·9166	0·9134
2·9	18·1741	·0550	9·1146	9·0596	·9940	·9597	0·9571
3·0	20·0855	·0498	10·068	10·018	·9951	1·0029	1·0008
3·1	22·1980	·0450	11·122	11·076	·9959	1·0462	1·0444
3·2	24·5325	·0408	12·287	12·246	·9967	1·0894	1·0880
3·3	27·1126	·0369	13·575	13·538	·9973	1·1327	1·1316
3·4	29·9641	·0334	14·999	14·965	·9978	1·1761	1·1751
3·5	33·1155	·0302	16·573	16·543	·9982	1·2194	1·2186
3·6	36·5982	·0273	18·313	18·285	·9985	1·2628	1·2621
3·7	40·4473	·0247	20·236	20·211	·9988	1·3061	1.3056
3·8	44·7012	·0224	22·362	22·339	·9990	1·3495	1·3491
3·9	49·4024	·0202	24·711	24·691	·9992	1·3929	1·3925
4·0	54·5982	·0183	27·308	27·290	·9993	1·4363	1·4360
4·1	60·3403	·0166	30·178	30·162	·9995	1·4797	1·4795
4·2	66·6863	·0150	33·351	33·336	·9996	1·5231	1·5229
4·3	73·6998	·0136	36·857	36·843	·9996	1·5665	1·5664
4·4	81·4509	·0123	40·732	40·719	·9997	1·6099	1·6098
4·5	90·0171	·0111	45·014	45·003	·9997	1·6533	1·6532
4·6	99·4843	·0101	49·747	49·737	·9998	1·6968	1·6967
4·7	109·9472	·0091	54·978	54·969	·9998	1·7402	1·7401
4·8	121·5104	·0082	60·759	60·751	·9999	1·7836	1·7836
4·9	134·2898	·0074	67·149	67·141	·9999	1·8270	1·8270
5·0	148·4132	·0067	74·210	74·203	·9999	1·8705	1·8704

Trigonometrical Ratios

Angle		*Chord*	*Sine*	*Tangent*	*Cotangent*	*Cosine*			
Degrees	*Radian*								
0°	0	0	0	0	∞	1	1·414	1·5708	90°
·5	·0087	·009	·0087	·0087	114·6	1	1·408	1·5621	89·5
1	·0175	·017	·0175	·0175	57·2900	·9998	1·402	1·5533	89
1·5	·0262	·025	·0262	·0262	38·19	·9997	1·396	1·5446	88·5
2	·0349	·035	·0349	·0349	28·6363	·9994	1·389	1·5359	88
2·5	·0436	·044	·0436	·0437	22·90	·9990	1·383	1·5272	87·5
3	·0524	·052	·0523	·0524	19·0811	·9986	1·377	1·5184	87
3·5	·0611	·061	·0610	·0612	16·35	·9981	1·370	1·5097	86·5
4	·0698	·070	·0698	·0699	14·3006	·9976	1·364	1·5010	86
4·5	·0785	·079	·0785	·0787	12·71	·9969	1·358	1·4923	85·5
5	·0873	·087	·0872	·0875	11·4301	·9962	1·351	1·4835	85
5·5	·0960	·096	·0958	·0963	10·39	·9954	1·345	1·4748	84·5
6	·1047	·105	·1045	·1051	9·5144	·9945	1·338	1·4661	84
6·5	·1134	·113	·1132	·1139	8·7769	·9936	1·332	1·4573	83·5
7	·1222	·122	·1219	·1228	8·1443	·9925	1·325	1·4486	83
7·5	·1309	·131	·1305	·1371	7·5958	·9914	1·319	1·4399	82·5
8	·1396	·139	·1392	·1405	7·1154	·9903	1·312	1·4312	82
8·5	·1484	·148	·1478	·1495	6·6912	·9890	1·306	1·4224	81·5
9	·1571	·157	·1564	·1584	6·3138	·9877	1·299	1·4137	81
9·5	·1658	·166	·1650	·1673	5·9758	·9863	1·292	1·4050	80·5
10	·1745	·174	·1736	·1763	5·6713	·9848	1·286	1·3963	80
10·5	·1833	·183	·1822	·1853	5·3955	·9833	1·279	1·3857	79·5
11	·1920	·192	·1908	·1944	5·1446	·9816	1·272	1·3788	79
11·5	·2007	·200	·1994	·2035	4·9152	·9799	1·265	1·3701	78·5
12	·2094	·209	·2079	·2126	4·7046	·9781	1·259	1·3614	78
12·5	·2182	·218	·2164	·2217	4·5107	·9763	1·252	1·3526	77·5
13	·2269	·226	·2250	·2309	4·3315	·9744	1·245	1·3439	77
13·5	·2356	·235	·2334	·2401	4·1653	·9724	1·238	1·3352	76·5
14	·2443	·244	·2419	·2493	4·0108	·9703	1·231	1·3265	76
14·5	·2531	·252	·2504	·2586	3·8667	·9681	1·224	1·3177	75·5
15	·2618	·261	·2588	·2679	3·7321	·9659	1·217	1·3090	75
15·5	·2705	·270	·2672	·2773	3·6059	·9636	1·211	1·3003	74·5
16	·2793	·278	·2756	·2867	3·4874	·9613	1·204	1·2915	74
16·5	·2880	·287	·2840	·2962	3·3759	·9588	1·197	1·2828	73·5
17	·2967	·296	·2924	·3057	3·2709	·9563	1·190	1·2741	73
17·5	·3054	·304	·3007	·3153	3·1716	·9537	1·183	1·2654	72·5
18	·3142	·313	·3090	·3249	3·0777	·9511	1·176	1·2566	72
18·5	·3229	·322	·3173	·3346	2·9887	·9483	1·168	1·2479	71·5
19	·3316	·330	·3256	·3443	2·9042	·9455	1·161	1·2392	71
19·5	·3403	·339	·3338	·3541	2·8239	·9426	1·154	1·2305	70·5
20	·3491	·347	·3420	·3640	2·7475	·9397	1·147	1·2217	70
20·5	·3578	·356	·3502	·3739	2·6746	·9367	1·140	1·2130	69·5
21	·3665	·364	·3584	·3839	2·6051	·9336	1·133	1·2043	69
21·5	·3752	·373	·3665	·3939	2·5386	·9304	1·126	1·1956	68·5
22	·3840	·382	·3746	·4040	2·4751	·9272	1·118	1·1868	68
			Cosine	*Co-tangent*	*Tangent*	*Sine*	*Chord*	*Radian*	*Deg.*
								Angle	

Angle		*Chord*	*Sine*	*Tangent*	*Co-tangent*	*Cosine*			
Degrees	*Radian*								
22·5	·3927	·390	·3827	·4142	2·4142	·9239	1·111	1·1781	67·5
23	·4014	·399	·3907	·4245	2·3559	·9205	1·104	1·1694	67
23·5	·4102	·407	·3987	·4348	2·2998	·9171	1·097	1·1606	66·5
24	·4189	·416	·4067	·4452	2·2460	·9135	1·089	1·1519	66
24·5	·4276	·424	·4147	·4557	2·1943	·9100	1·082	1·1432	65·5
25	·4363	·433	·4226	·4663	2·1445	·9063	1·075	1·1345	65
25·5	·4451	·441	·4305	·4770	2·0965	·9026	1·067	1·1257	64·5
26	·4538	·450	·4384	·4877	2·0503	·8988	1·060	1·1170	64
26·5	·4625	·458	·4462	·4986	2·0057	·8949	1·052	1·1083	63·5
27	·4712	·467	·4540	·5095	1·9626	·8910	1·045	1·0996	63
27·5	·4800	·475	·4617	·5206	1·9210	·8870	1·037	1·0908	62·5
28	·4887	·484	·4695	·5317	1·8807	·8829	1·030	1·0821	62
28·5	·4974	·492	·4772	·5430	1·8418	·8788	1·023	1·0734	61·5
29	·5061	·501	·4848	·5543	1·8040	·8746	1·015	1·0647	61
29·5	·5149	·509	·4924	·5658	1·7675	·8704	1·008	1·0559	60·5
30	·5236	·518	·5000	·5774	1·7321	·8660	1·000	1·0472	60
30·5	·5323	·526	·5075	·5890	1·6977	·8616	·993	1·0385	59·5
31	·5411	·534	·5150	·6009	1·6643	·8572	·985	1·0297	59
31·5	·5498	·543	·5225	·6128	1·6319	·8526	·977	1·0210	58·5
32	·5585	·551	·5299	·6249	1·6003	·8480	·970	1·0123	58
32·5	·5672	·560	·5373	·6371	1·5697	·8434	·962	1·0036	57·5
33	·5760	·568	·5446	·6494	1·5399	·8387	·954	·9948	57
33·5	·5847	·576	·5519	·6619	1·5108	·8339	·947	·9861	56·5
34	·5934	·585	·5592	·6745	1·4826	·8290	·939	·9774	56
34·5	·6021	·593	·5664	·6873	1·4550	·8241	·931	·9687	55·5
35	·6109	·601	·5736	·7002	1·4281	·8192	·923	·9599	55
35·5	·6196	·609	·5807	·7133	1·4019	·8141	·916	·9512	54·5
36	·6283	·618	·5878	·7265	1·3764	·8090	·908	·9425	54
36·5	·6370	·626	·5948	·7400	1·3514	·8039	·900	·9338	53·5
37	·6458	·635	·6018	·7536	1·3270	·7986	·892	·9250	53
37·5	·6545	·643	·6088	·7673	1·3032	·7934	·885	·9163	52·5
38	·6632	·651	·6157	·7813	1·2799	·7880	·877	·9076	52
38·5	·6720	·659	·6225	·7954	1·2572	·7826	·871	·8988	51·5
39	·6807	·668	·6293	·8098	1·2349	·7771	·861	·8901	51
39·5	·6894	·676	·6361	·8243	1·2131	·7716	·853	·8814	50·5
40	·6981	·684	·6428	·8391	1·1918	·7660	·845	·8727	50
40·5	·7069	·692	·6494	·8541	1·1708	·7604	·837	·8639	49·5
41	·7156	·700	·6561	·8693	1·1504	·7547	·829	·8552	49
41·5	·7243	·709	·6626	·8847	1·1303	·7490	·821	·8465	48·5
42	·7330	·717	·6691	·9004	1·1106	·7431	·813	·8378	48
42·5	·7418	·725	·6756	·9163	1·0913	·7373	·805	·8290	47·5
43	·7505	·733	·6820	·9325	1·0724	·7314	·796	·8203	47
43·5	·7592	·741	·6884	·9490	1·0538	·7254	·789	·8116	46·5
44	·7679	·749	·6947	·9657	1·0355	·7193	·781	·8029	46
44·5	·7767	·757	·7009	·9827	1·0176	·7133	·773	·7941	45·5
45	·7854	·765	·7071	1·0000	1·0000	·7071	·765	·7854	45
			Cosine	*Co-tangent*	*Tangent*	*Sine*	*Chord*	*Radian*	*Deg.*
								Angle	

$\sqrt{3}$

$\sqrt{2}/2$

Natural Sines, Tangents, Cotangents and Cosines

To Ten Minutes of Arc

°	′	Sine	Tan.	Cotan.	Cosine	′	°	°	′	Sine	Tan.	Cotan.	Cosine	′	°
0	0	0.0000	0.0000	Infinite	1.0000	0	90	11	0	0.1908	0.1944	5.1446	0.9816	0	79
	10	0.0029	0.0029	343.7737	1.0000	50			10	0.1937	0.1974	5.0658	0.9811	50	
	20	0.0058	0.0058	171.8854	1.0000	40			20	0.1965	0.2004	4.9894	0.9805	40	
	30	0.0087	0.0087	114.5887	1.0000	30			30	0.1994	0.2035	4.9152	0.9799	30	
	40	0.0116	0.0116	85.9398	0.9999	20			40	0.2022	0.2065	4.8430	0.9793	20	
	50	0.0145	0.0145	68.7501	0.9999	10			50	0.2051	0.2095	4.7729	0.9787	10	
1	0	0.0175	0.0175	57.2900	0.9998	0	89	12	0	0.2079	0.2126	4.7046	0.9781	0	78
	10	0.0204	0.0204	49.1039	0.9998	50			10	0.2108	0.2156	4.6382	0.9775	50	
	20	0.0233	0.0233	42.9641	0.9997	40			20	0.2136	0.2186	4.5736	0.9769	40	
	30	0.0262	0.0262	38.1885	0.9997	30			30	0.2164	0.2217	4.5107	0.9763	30	
	40	0.0291	0.0291	34.3678	0.9996	20			40	0.2193	0.2247	4.4494	0.9757	20	
	50	0.0320	0.0320	31.2416	0.9995	10			50	0.2221	0.2278	4.3897	0.9750	10	
2	0	0.0349	0.0349	28.6363	0.9994	0	88	13	0	0.2250	0.2309	4.3315	0.9744	0	77
	10	0.0378	0.0378	26.4316	0.9993	50			10	0.2278	0.2339	4.2747	0.9737	50	
	20	0.0407	0.0407	24.5418	0.9992	40			20	0.2306	0.2370	4.2193	0.9730	40	
	30	0.0436	0.0437	22.9038	0.9990	30			30	0.2334	0.2401	4.1653	0.9724	30	
	40	0.0465	0.0466	21.4704	0.9989	20			40	0.2363	0.2432	4.1126	0.9717	20	
	50	0.0494	0.0495	20.2056	0.9988	10			50	0.2391	0.2462	4.0611	0.9710	10	
3	0	0.0523	0.0524	19.0811	0.9986	0	87	14	0	0.2419	0.2493	4.0108	0.9703	0	76
	10	0.0552	0.0553	18.0750	0.9985	50			10	0.2447	0.2524	3.9617	0.9696	50	
	20	0.0581	0.0582	17.1693	0.9983	40			20	0.2476	0.2555	3.9136	0.9689	40	
	30	0.0610	0.0612	16.3499	0.9981	30			30	0.2504	0.2586	3.8667	0.9681	30	
	40	0.0640	0.0641	15.6048	0.9980	20			40	0.2532	0.2617	3.8208	0.9674	20	
	50	0.0669	0.0670	14.9244	0.9978	10			50	0.2560	0.2648	3.7760	0.9667	10	
4	0	0.0698	0.0699	14.3007	0.9976	0	86	15	0	0.2588	0.2679	3.7321	0.9659	0	75
	10	0.0727	0.0729	13.7267	0.9974	50			10	0.2616	0.2711	3.6891	0.9652	50	
	20	0.0756	0.0758	13.1969	0.9971	40			20	0.2644	0.2742	3.6470	0.9644	40	
	30	0.0785	0.0787	12.7062	0.9969	30			30	0.2672	0.2773	3.6059	0.9636	30	
	40	0.0814	0.0816	12.2505	0.9967	20			40	0.2700	0.2805	3.5656	0.9628	20	
	50	0.0843	0.0846	11.8262	0.9964	10			50	0.2728	0.2836	3.5261	0.9621	10	
5	0	0.0872	0.0875	11.4301	0.9962	0	85	16	0	0.2756	0.2867	3.4874	0.9613	0	74
	10	0.0901	0.0904	11.0594	0.9959	50			10	0.2784	0.2899	3.4495	0.9605	50	
	20	0.0929	0.0934	10.7119	0.9957	40			20	0.2812	0.2931	3.4124	0.9596	40	
	30	0.0958	0.0963	10.3854	0.9954	30			30	0.2840	0.2962	3.3759	0.9588	30	
	40	0.0987	0.0992	10.0780	0.9951	20			40	0.2868	0.2994	3.3402	0.9580	20	
	50	0.1016	0.1022	9.7882	0.9948	10			50	0.2896	0.3026	3.3052	0.9572	10	
6	0	0.1045	0.1051	9.5144	0.9945	0	84	17	0	0.2924	0.3057	3.2709	0.9563	0	73
	10	0.1074	0.1080	9.2553	0.9942	50			10	0.2952	0.3089	3.2371	0.9555	50	
	20	0.1103	0.1110	9.0098	0.9939	40			20	0.2979	0.3121	3.2041	0.9546	40	
	30	0.1132	0.1139	8.7769	0.9936	30			30	0.3007	0.3153	3.1716	0.9537	30	
	40	0.1161	0.1169	8.5555	0.9932	20			40	0.3035	0.3185	3.1397	0.9528	20	
	50	0.1190	0.1198	8.3450	0.9929	10			50	0.3062	0.3217	3.1084	0.9520	10	
7	0	0.1219	0.1228	8.1443	0.9925	0	83	18	0	0.3090	0.3249	3.0777	0.9511	0	72
	10	0.1248	0.1257	7.9530	0.9922	50			10	0.3118	0.3281	3.0475	0.9502	50	
	20	0.1276	0.1287	7.7704	0.9918	40			20	0.3145	0.3314	3.0178	0.9492	40	
	30	0.1305	0.1317	7.5958	0.9914	30			30	0.3173	0.3346	2.9887	0.9483	30	
	40	0.1334	0.1346	7.4287	0.9911	20			40	0.3201	0.3378	2.9600	0.9474	20	
	50	0.1363	0.1376	7.2687	0.9907	10			50	0.3228	0.3411	2.9319	0.9465	10	
8	0	0.1392	0.1405	7.1154	0.9903	0	82	19	0	0.3256	0.3443	2.9042	0.9455	0	71
	10	0.1421	0.1435	6.9682	0.9899	50			10	0.3283	0.3476	2.8770	0.9446	50	
	20	0.1449	0.1465	6.8269	0.9894	40			20	0.3311	0.3508	2.8502	0.9436	40	
	30	0.1478	0.1495	6.6912	0.9890	30			30	0.3338	0.3541	2.8239	0.9426	30	
	40	0.1507	0.1524	6.5606	0.9886	20			40	0.3365	0.3574	2.7980	0.9417	20	
	50	0.1536	0.1554	6.4348	0.9881	10			50	0.3393	0.3607	2.7725	0.9407	10	
9	0	0.1564	0.1584	6.3138	0.9877	0	81	20	0	0.3420	0.3640	2.7475	0.9397	0	70
	10	0.1593	0.1614	6.1970	0.9872	50			10	0.3448	0.3673	2.7228	0.9387	50	
	20	0.1622	0.1644	6.0844	0.9868	40			20	0.3475	0.3706	2.6985	0.9377	40	
	30	0.1650	0.1673	5.9758	0.9863	30			30	0.3502	0.3739	2.6746	0.9367	30	
	40	0.1679	0.1703	5.8708	0.9858	20			40	0.3529	0.3772	2.6511	0.9356	20	
	50	0.1708	0.1733	5.7694	0.9853	10			50	0.3557	0.3805	2.6279	0.9346	10	
10	0	0.1736	0.1763	5.6713	0.9848	0	80	21	0	0.3584	0.3839	2.6051	0.9336	0	69
	10	0.1765	0.1793	5.5764	0.9843	50			10	0.3611	0.3872	2.5826	0.9325	50	
	20	0.1794	0.1823	5.4845	0.9838	40			20	0.3638	0.3906	2.5605	0.9315	40	
	30	0.1822	0.1853	5.3955	0.9833	30			30	0.3665	0.3939	2.5386	0.9304	30	
	40	0.1851	0.1883	5.3093	0.9827	20			40	0.3692	0.3973	2.5172	0.9293	20	
	50	0.1880	0.1914	5.2257	0.9822	10			50	0.3719	0.4006	2.4960	0.9283	10	
°	′	Cosine	Cotan.	Tan.	Sine	′	°	°	′	Cosine	Cotan.	Tan.	Sine	′	°

°	′	Sine	Tan.	Cotan.	Cosine	′	°
22	0	0.3746	0.4040	2.4751	0.9272	0	68
	10	0.3773	0.4074	2.4545	0.9261	50	
	20	0.3800	0.4108	2.4342	0.9250	40	
	30	0.3827	0.4142	2.4142	0.9239	30	
	40	0.3854	0.4176	2.3945	0.9228	20	
	50	0.3881	0.4210	2.3750	0.9216	10	
23	0	0.3907	0.4245	2.3559	0.9205	0	67
	10	0.3934	0.4279	2.3369	0.9194	50	
	20	0.3961	0.4314	2.3183	0.9182	40	
	30	0.3987	0.4348	2.2998	0.9171	30	
	40	0.4014	0.4383	2.2817	0.9159	20	
	50	0.4041	0.4417	2.2637	0.9147	10	
24	0	0.4067	0.4452	2.2460	0.9135	0	66
	10	0.4094	0.4487	2.2286	0.9124	50	
	20	0.4120	0.4522	2.2113	0.9112	40	
	30	0.4147	0.4557	2.1943	0.9100	30	
	40	0.4173	0.4592	2.1775	0.9088	20	
	50	0.4200	0.4628	2.1609	0.9075	10	
25	0	0.4226	0.4663	2.1445	0.9063	0	65
	10	0.4253	0.4699	2.1283	0.9051	50	
	20	0.4279	0.4734	2.1123	0.9038	40	
	30	0.4305	0.4770	2.0965	0.9026	30	
	40	0.4331	0.4806	2.0809	0.9013	20	
	50	0.4358	0.4841	2.0655	0.9001	10	
26	0	0.4384	0.4877	2.0503	0.8988	0	64
	10	0.4410	0.4913	2.0353	0.8975	50	
	20	0.4436	0.4950	2.0204	0.8962	40	
	30	0.4462	0.4986	2.0057	0.8949	30	
	40	0.4488	0.5022	1.9912	0.8936	20	
	50	0.4514	0.5059	1.9768	0.8923	10	
27	0	0.4540	0.5095	1.9626	0.8910	0	63
	10	0.4566	0.5132	1.9486	0.8897	50	
	20	0.4592	0.5169	1.9347	0.8884	40	
	30	0.4617	0.5206	1.9210	0.8870	30	
	40	0.4643	0.5243	1.9074	0.8857	20	
	50	0.4669	0.5280	1.8940	0.8843	10	
28	0	0.4695	0.5317	1.8807	0.8829	0	62
	10	0.4720	0.5354	1.8676	0.8816	50	
	20	0.4746	0.5392	1.8546	0.8802	40	
	30	0.4772	0.5430	1.8418	0.8788	30	
	40	0.4797	0.5467	1.8291	0.8774	20	
	50	0.4823	0.5505	1.8165	0.8760	10	
29	0	0.4848	0.5543	1.8040	0.8746	0	61
	10	0.4874	0.5581	1.7917	0.8732	50	
	20	0.4899	0.5619	1:7796	0.8718	40	
	30	0.4924	0.5658	1.7675	0.8704	30	
	40	0.4950	0.5696	1.7556	0.8689	20	
	50	0.4975	0.5735	1.7437	0.8675	10	
30	0	0.5000	0.5774	1.7321	0.8660	0	60
	10	0.5025	0.5812	1.7205	0.8646	50	
	20	0.5050	0.5851	1.7090	0.8631	40	
	30	0.5075	0.5890	1.6977	0.8616	30	
	40	0.5100	0.5930	1.6864	0.8601	20	
	50	0.5125	0.5969	1.6753	0.8587	10	
31	0	0.5150	0.6009	1.6643	0.8572	0	59
	10	0.5175	0.6048	1.6534	0.8557	50	
	20	0.5200	0.6088	1.6426	0.8542	40	
	30	0.5225	0.6128	1.6319	0.8526	30	
	40	0.5250	0.6168	1.6212	0.8511	20	
	50	0.5275	0.6208	1.6107	0.8496	10	
32	0	0.5299	0.6249	1.6003	0.8480	0	58
	10	0.5324	0.6289	1.5900	0.8465	50	
	20	0.5348	0.6330	1.5798	0.8450	40	
	30	0.5373	0.6371	1.5697	0.8434	30	
	40	0.5398	0.6412	1.5597	0.8418	20	
	50	0.5422	0.6453	1.5497	0.8403	10	
33	0	0.5446	0.6494	1.5399	0.8387	0	57
	10	0.5471	0.6536	1.5301	0.8371	50	
	20	0.5495	0.6577	1.5204	0.8355	40	
°	′	Cosine	Cotan.	Tan.	Sine	′	°

°	′	Sine	Tan.	Cotan.	Cosine	′	°
	30	0.5519	0.6619	1.5108	0.8339	30	
	40	0.5544	0.6661	1.5013	0.8323	20	
	50	0.5568	0.6703	1.4919	0.8307	10	
34	0	0.5592	0.6745	1.4826	0.8290	0	56
	10	0.5616	0.6787	1.4733	0.8274	50	
	20	0.5640	0.6830	1.4641	0.8258	40	
	30	0.5664	0.6873	1.4550	0.8241	30	
	40	0.5688	0.6916	1.4460	0.8225	20	
	50	0.5712	0.6959	1.4370	0.8208	10	
35	0	0.5736	0.7002	1.4281	0.8192	0	55
	10	0.5760	0.7046	1.4193	0.8175	50	
	20	0.5783	0.7089	1.4106	0.8158	40	
	30	0.5807	0.7133	1.4019	0.8141	30	
	40	0.5831	0.7177	1.3934	0.8124	20	
	50	0.5854	0.7221	1.3848	0.8107	10	
36	0	0.5878	0.7265	1.3764	0.8090	0	54
	10	0.5901	0.7310	1.3680	0.8073	50	
	20	0.5925	0.7355	1.3597	0.8056	40	
	30	0.5948	0.7400	1.3514	0.8039	30	
	40	0.5972	0.7445	1.3432	0.8021	20	
	50	0.5995	0.7490	1.3351	0.8004	10	
37	0	0.6018	0.7536	1.3270	0.7986	0	53
	10	0.6041	0.7581	1.3190	0.7969	50	
	20	0.6065	0.7627	1.3111	0.7951	40	
	30	0.6088	0.7673	1.3032	0.7934	30	
	40	0.6111	0.7720	1.2954	0.7916	20	
	50	0.6134	0.7766	1.2876	0.7898	10	
38	0	0.6157	0.7813	1.2799	0.7880	0	52
	10	0.6180	0.7860	1.2723	0.7862	50	
	20	0.6202	0.7907	1.2647	0.7844	40	
	30	0.6225	0.7954	1.2572	0.7826	30	
	40	0.6248	0.8002	1.2497	0.7808	20	
	50	0.6271	0.8050	1.2423	0.7790	10	
39	0	0.6293	0.8098	1.2349	0.7771	0	51
	10	0.6316	0.8146	1.2276	0.7753	50	
	20	0.6338	0.8195	1.2203	0.7735	40	
	30	0.6361	0.8243	1.2131	0.7716	30	
	40	0.6383	0.8292	1.2059	0.7698	20	
	50	0.6406	0.8342	1.1988	0.7679	10	
40	0	0.6428	0.8391	1.1918	0.7660	0	50
	10	0.6450	0.8441	1.1847	0.7642	50	
	20	0.6472	0.8491	1.1778	0.7623	40	
	30	0.6494	0.8541	1.1708	0.7604	30	
	40	0.6517	0.8591	1.1640	0.7585	20	
	50	0.6539	0.8642	1.1571	0.7566	10	
41	0	0.6561	0.8693	1.1504	0.7547	0	49
	10	0.6583	0.8744	1.1436	0.7528	50	
	20	0.6604	0.8796	1.1369	0.7509	40	
	30	0.6626	0.8847	1.1303	0.7490	30	
	40	0.6648	0.8899	1.1237	0.7470	20	
	50	0.6670	0.8952	1.1171	0.7451	10	
42	0	0.6691	0.9004	1.1106	0.7431	0	48
	10	0.6713	0.9057	1.1041	0.7412	50	
	20	0.6734	0.9110	1.0977	0.7392	40	
	30	0.6756	0.9163	1.0913	0.7373	30	
	40	0.6777	0.9217	1.0850	0.7353	20	
	50	0.6799	0.9271	1.0786	0.7333	10	
43	0	0.6820	0.9325	1.0724	0.7314	0	47
	10	0.6841	0.9380	1.0661	0.7294	50	
	20	0.6862	0.9435	1.0599	0.7274	40	
	30	0.6884	0.9490	1.0538	0.7254	30	
	40	0.6905	0.9545	1.0477	0.7234	20	
	50	0.6926	0.9601	1.0416	0.7214	10	
44	0	0.6947	0.9657	1.0355	0.7193	0	46
	10	0.6967	0.9713	1.0295	0.7173	50	
	20	0.6988	0.9770	1.0235	0.7153	40	
	30	0.7009	0.9827	1.0176	0.7133	30	
	40	0.7030	0.9884	1.0117	0.7112	20	
	50	0.7050	0.9942	1.0058	0.7092	10	
45	0	0.7071	1.0000	1.0000	0.7071	0	45
°	′	Cosine	Cotan.	Tan.	Sine	′	°

Hyperbolic Napierian Logarithms

or logarithms to the base *e*. $e = 2.71828+$

No.	0	1	2	3	4	5	6	7	8	9
1.0	0.0000	0.0099	0.0198	0.0296	0.0392	0.0488	0.0583	0.0677	0.0770	0.0862
1.1	.0953	.1044	.1133	.1222	.1310	.1383	.1484	.1570	.1655	.1740
1.2	.1823	.1906	.1989	.2070	.2151	.2231	.2311	.2390	.2469	.2546
1.3	.2624	.2700	.2776	.2852	.2927	.3001	.3075	.3148	.3221	.3293
1.4	.3365	.3436	.3507	.3577	.3646	.3716	.3784	.3853	.3920	.3988
1.5	.4055	.4121	.4187	.4253	.4318	.4383	.4447	.4511	.4574	.4637
1.6	.4700	.4762	.4824	.4886	.4947	.5008	.5068	.5128	.5188	.5247
1.7	.5306	.5365	.5423	.5481	.5539	.5596	.5653	.5710	.5766	.5822
1.8	.5878	.5933	.5988	.6043	.6098	.6152	.6206	.6259	.6313	.6366
1.9	.6419	.6471	.6523	.6575	.6627	.6678	.6729	.6780	.6831	.6881
2.0	.6931	.6981	.7031	.7080	.7129	.7178	.7227	.7275	.7324	.7372
2.1	.7419	.7467	.7514	.7561	.7608	.7655	.7701	.7747	.7793	.7839
2.2	.7885	.7930	.7975	.8020	.8065	.8109	.8154	.8198	.8242	.8286
2.3	.8329	.8372	.8416	.8459	.8502	.8544	.8587	.8629	.8671	.8713
2.4	.8755	.8796	.8838	.8879	.8920	.8961	.9002	.9042	.9083	.9123
2.5	.9163	.9203	.9243	.9282	.9322	.9361	.9400	.9439	.9478	.9517
2.6	.9555	.9594	0.9632	0.9670	0.9708	0.9746	0.9783	0.9821	0.9858	0.9895
2.7	0.9933	0.9969	1.0006	1.0043	1.0080	1.0116	1.0152	1.0188	1.0225	1.0260
2.8	1.0296	1.0332	.0367	.0403	.0438	.0473	.0508	.0543	.0578	.0613
2.9	.0647	.0682	.0716	.0750	.0784	.0818	.0852	.0886	.0919	.0953
3.0	.0986	.1019	.1053	.1086	.1119	.1151	.1184	.1217	.1249	.1282
3.1	.1314	.1346	.1378	.1410	.1442	.1474	.1506	.1537	.1569	.1600
3.2	.1632	.1663	.1694	.1725	.1756	.1787	.1817	.1848	.1878	.1909
3.3	.1939	.1969	.2000	.2030	.2060	.2090	.2119	.2149	.2179	.2208
3.4	.2238	.2267	.2296	.2326	.2355	.2384	.2413	.2442	.2470	.2499
3.5	.2528	.2556	.2585	.2613	.2641	.2669	.2698	.2726	.2754	.2782
3.6	.2809	.2837	.2865	.2892	.2920	.2947	.2975	.3002	.3029	.3056
3.7	.3083	.3110	.3137	.3164	.3191	.3218	.3244	.3271	.3297	.3324
3.8	.3350	.3376	.3403	.3429	.3455	.3481	.3507	.3533	.3558	.3584
3.9	.3610	.3635	.3661	.3686	.3712	.3737	.3762	.3788	.3813	.3838
4.0	.3863	.3888	.3913	.3938	.3962	.3987	.4012	.4036	.4061	.4085
4.1	.4110	.4134	.4159	.4183	.4207	.4231	.4255	.4279	.4303	.4327
4.2	.4351	.4375	.4398	.4422	.4446	.4469	.4493	.4516	.4540	.4563
4.3	.4586	.4609	.4633	.4656	.4679	.4702	.4725	.4748	.4770	.4793
4.4	.4816	.4839	.4861	.4884	.4907	.4929	.4951	.4974	.4996	.5019
4.5	.5041	.5063	.5085	.5107	.5129	.5151	.5173	.5195	.5217	.5239
4.6	.5261	.5282	.5304	.5326	.5347	.5369	.5390	.5412	.5433	.5454
4.7	.5476	.5497	.5518	.5539	.5560	.5581	.5602	.5623	.5644	.5665
4.8	.5686	.5707	.5728	.5748	.5769	.5790	.5810	.5831	.5851	.5872
4.9	.5892	.5913	.5933	.5953	.5974	.5994	.6014	.6034	.6054	.6074
5.0	.6094	.6114	.6134	.6154	.6174	.6194	.6214	.6233	.6253	.6273
5.1	.6292	.6312	.6332	.6351	.6371	.6390	.6409	.6429	.6448	.6467
5.2	.6487	.6506	.6525	.6544	.6563	.6582	.6601	.6620	.6639	.6658
5.3	.6677	.6696	.6715	.6734	.6752	.6771	.6790	.6808	.6827	.6845
5.4	.6864	.6882	.6901	.6919	.6938	.6956	.6974	.6993	.7011	.7029
5.5	.7047	.7066	.7084	.7102	.7120	.7138	.7156	.7174	.7192	.7210
5.6	.7228	.7246	.7263	.7281	.7299	.7317	.7334	.7352	.7370	.7387
5.7	.7405	.7422	.7440	.7457	.7475	.7492	.7509	.7527	.7544	.7561
5.8	.7579	.7596	.7613	.7630	.7647	.7664	.7681	.7699	.7716	.7733
5.9	.7750	.7766	.7783	.7800	.7817	.7834	.7851	.7867	.7884	.7901
6.0	.7918	.7934	.7951	.7967	.7984	.8001	.8017	.8034	.8050	.8066
6.1	.8083	.8099	.8116	.8132	.8148	.8165	.8181	.8197	.8213	.8229
6.2	.8245	.8262	.8278	.8294	.8310	.8326	.8342	.8358	.8374	.8390
6.3	.8405	.8421	.8437	.8453	.8469	.8485	.8500	.8516	.8532	.8547
6.4	.8563	.8579	.8594	.8610	.8625	.8641	.8656	.8672	.8687	.8703
6.5	.8718	.8733	.8749	.8764	.8779	.8795	.8810	.8825	.8840	.8856
6.6	.8871	.8886	.8901	.8916	.8931	.8946	.8961	.8976	.8991	.9006
6.7	.9021	.9036	.9051	.9066	.9081	.9095	.9110	.9125	.9140	.9155
6.8	.9169	.9184	.9199	.9213	.9228	.9242	.9257	.9272	.9286	.9301
6.9	.9315	.9330	.9344	.9359	.9373	.9387	.9402	.9416	.9430	.9445
7.0	.9459	.9473	.9488	.9502	.9516	.9530	.9544	.9559	.9573	.9587
7.1	.9601	.9615	.9629	.9643	.9657	.9671	.9685	.9699	.9713	.9727
7.2	.9741	.9755	.9769	.9782	.9796	.9810	.9824	.9838	.9851	1.9865
7.3	1.9879	1.9892	1.9906	1.9920	1.9933	1.9947	1.9961	1.9974	1.9988	2.0001
7.4	2.0015	2.0028	2.0042	2.0055	2.0069	2.0082	2.0096	2.0109	2.0122	2.0136

Hyperbolic Napierian Logarithms—Cont.

No.	0	1	2	3	4	5	6	7	8	9
7.5	2.0149	2.0162	2.0176	2.0189	2.0202	2.0215	2.0229	2.0242	2.0255	2.0268
7.6	.0281	.0295	.0308	.0321	.0334	.0347	.0360	.0373	.0386	.0399
7.7	.0412	.0425	.0438	.0451	.0464	.0477	.0490	.0503	.0516	.0528
7.8	.0541	.0554	.0567	.0580	.0592	.0605	.0618	.0631	.0643	.0656
7.9	.0669	.0681	.0694	.0707	.0719	.0732	.0744	.0757	.0769	.0782
8.0	.0794	.0807	.0819	.0832	.0844	.0857	.0869	.0882	.0894	.0906
8.1	.0919	.0931	.0943	.0956	.0968	.0980	.0992	.1005	.1017	.1029
8.2	.1041	.1054	.1066	.1078	.1090	.1102	.1114	.1126	.1138	.1150
8.3	.1163	.1175	.1187	.1199	.1211	.1223	.1235	.1247	.1258	.1270
8.4	.1282	.1294	.1306	.1318	.1330	.1342	.1353	.1365	.1377	.1389
8.5	.1401	.1412	.1424	.1436	.1448	.1459	.1471	.1483	.1494	.1506
8.6	.1518	.1529	.1541	.1552	.1564	.1576	.1587	.1599	.1610	.1622
8.7	.1633	.1645	.1656	.1668	.1679	.1691	.1702	.1713	.1725	.1736
8.8	.1748	.1759	.1770	.1782	.1793	.1804	.1815	.1827	.1838	.1849
8.9	.1861	.1872	.1883	.1894	.1905	.1917	.1928	.1939	.1950	.1961
9.0	.1972	.1983	.1994	.2006	.2017	.2028	.2039	.2050	.2061	.2072
9.1	.2083	.2094	.2105	.2116	.2127	.2138	.2148	.2159	.2170	.2181
9.2	.2192	.2203	.2214	.2225	.2235	.2246	.2257	.2268	.2279	.2289
9.3	.2300	.2311	.2322	.2332	.2343	.2354	.2364	.2375	.2386	.2396
9.4	.2407	.2418	.2428	.2439	.2450	.2460	.2471	.2481	.2492	.2502
9.5	.2513	.2523	.2534	.2544	.2555	.2565	.2576	.2586	.2597	.2607
9.6	.2618	.2628	.2638	.2649	.2659	.2670	.2680	.2690	.2701	.2711
9.7	.2721	.2732	.2742	.2752	.2762	.2773	.2783	.2793	.2803	.2814
9.8	.2824	.2834	.2844	.2864	.2865	.2875	.2885	.2895	.2905	.2915
9.9	2.2925	2.2935	2.2946	2.2956	2.2966	2.2976	2.2986	2.2996	2.3006	2.3016
10.	2.3026	2.3125	2.3224	2.3322	2.3418	2.3513	2.3609	2.3702	2.3795	2.3887
11.	.3979	.4069	.4159	.4248	.4336	.4423	.4510	.4596	.4681	.4765
12.	.4849	.4932	.5014	.5096	.5177	.5257	.5337	.5416	.5494	.5574
13.	.5649	.5726	.5802	.5877	.5953	.6027	.6101	.6174	.6247	.6319
14.	.6391	.6461	.6532	.6602	.6672	.6741	.6810	.6878	.6946	.7013
15.	.7081	.7147	.7213	.7278	.7344	.7408	.7473	.7536	.7600	.7663
16.	.7726	.7788	.7850	.7911	.7973	.8033	.8094	.8154	.8214	.8273
17.	.8332	.8391	.8449	.8507	.8565	.8622	.8679	.8735	.8792	.8848
18.	.8904	.8959	.9014	.9069	.9124	.9178	.9232	.9285	.9339	.9391
19.	.9444	2.9497	2.9549	2.9601	2.9653	2.9704	2.9755	2.9806	2.9857	2.9907
20.	2.9957	3.0007	3.0057	3.0106	3.0155	3.0204	3.0253	3.0301	3.0350	3.0397
21.	3.0445	.0493	.0540	.0587	.0634	.0681	.0727	.0773	.0819	.0864
22.	.0910	.0956	.1001	.1046	.1091	.1135	.1180	.1224	.1268	.1311
23.	.1355	.1398	.1442	.1484	.1527	.1570	.1612	.1655	.1697	.1739
24.	.1781	.1822	.1864	.1905	.1946	.1987	.2027	.2068	.2108	.2149
25.	.2189	.2229	.2268	.2308	.2347	.2387	.2426	.2465	.2504	.2542
26.	.2581	.2619	.2658	.2696	.2734	.2771	.2809	.2847	.2884	.2921
27.	.2958	.2995	.3032	.3169	.3105	.3142	.3178	.3214	.3250	.3286
28.	.3322	.3358	.3393	.3428	.3464	.3499	.3534	.3569	.3604	.3638
29.	.3673	.3707	.3742	.3776	.3810	.3844	.3878	.3911	.3945	.3979
30.	.4012	.4045	.4078	.4111	.4144	.4177	.4210	.4243	.4275	.4307
31.	.4340	.4372	.4404	.4436	.4468	.4500	.4532	.4563	.4595	.4626
32.	.4657	.4689	.4720	.4751	.4781	.4812	.4843	.4974	.4904	.4935
33.	.4965	.4995	.5025	.5055	.5085	.5115	.5145	.5175	.5205	.5234
34.	3.5264	3.5393	3.5322	3.5351	3.5380	3.5410	3.5439	3.5467	3.5496	3.5525

Metric and Decimal Equivalent of Fractions

Inches		m/m.	Inches		m/m.	Inches		m/m.	Inches		m/m.
1/64	·016	0·396	17/64	·266	6·746	33/64	·516	13·096	49/64	·766	19·446
1/32	·031	0·793	9/32	·281	7·143	17/32	·531	13·492	25/32	·781	19·842
3/64	·047	1·190	19/64	·297	7·540	35/64	·547	13·890	51/64	·797	20·239
1/16	·063	1·587	5/16	·313	7·937	9/16	·563	14·287	13/16	·813	20·637
5/64	·078	1·984	21/64	·328	8·334	37/64	·578	14·683	53/64	·828	21·033
3/32	·094	2·381	11/32	·344	8·730	19/32	·594	15·080	27/32	·844	21·429
7/64	·109	2·778	23/64	·359	9·127	39/64	·609	15·477	55/64	·859	21·827
1/8	·125	3·175	3/8	·375	9·525	5/8	·625	15·875	7/8	·875	22·225
9/64	·141	3·571	25/64	·391	9·921	41/64	·641	16·271	57/64	·891	22·621
5/32	·156	3·968	13/32	·406	10·318	21/32	·656	16·667	29/32	·906	23·017
11/64	·172	4·365	27/64	·422	10·715	43/64	·672	17·064	59/64	·922	23·414
3/16	·188	4·762	7/16	·438	11·112	11/16	·688	17·462	15/16	·938	23·812
23/64	·203	5·159	29/64	·453	11·508	45/64	·703	17·858	61/64	·953	24·208
7/32	·219	5·556	15/32	·469	11·905	23/32	·719	18·255	31/32	·969	24·604
15/64	·234	5·955	31/64	·484	12·302	47/64	·734	18·652	63/64	·984	25·002
1/4	·25	6·350	1/2	·5	12·700	3/4	·75	19·050			

Whitworth and Conduit Threads

Whitworth

Nominal Dia. (in.)	Depth of Thread (in.)	Threads per in.
1/8	0·0160	40
3/16	0·0267	24
7/32		
1/4	0·0320	20
9/32		
5/16	0·0356	18
3/8	0·0400	16
7/16	0·0457	14
1/2	0·0534	12
9/16	0·0534	12
5/8	0·0582	11
11/16	0·0582	11
3/4	0·0640	10
13/16		
7/8	0·0711	9
1	0·0800	8
1 1/8	0·0915	7
1 1/4	0·0915	7
1 3/8		
1 1/2	0·1067	6
1 5/8		
1 3/4	0·1281	5
2	0·1423	4·5

Conduit

Ext. Dia. (in.)	Depth of thread (in.)	Threads per in.
1/2	0·0356	18
5/8	0·0356	18
3/4	0·0400	16
1	0·0400	16
1 1/4	0·0400	16
1 1/2	0·0457	14
2	0·0457	14
2 1/2	0·0457	14

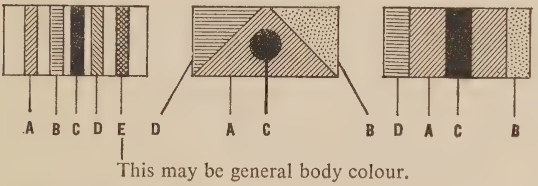
Resistors and Capacitors

Resistors

Preferred values of resistors from 10 ohms upwards are as follows: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 ohms × 1, × 10, × 100 etc. These values represent approximately a geometric series increasing by 20% for each value.

Resistor values are identified by a standard colour code as follows:

COLOURED BAND MARKING — BODY, TIP AND SPOT MARKING — BODY, TIP AND CENTRAL BAND MARKING



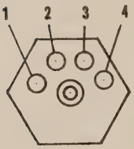
Colour	*1st Digit* (A)	*2nd Digit* (B)	*Multiplier* (C)	*Tolerance* (D)	*Grade* (E)
Silver			10^{-2}	±10%	
Gold			10^{-1}	± 5%	
Black		0	1		
Brown	1	1	10	± 1%	
Red	2	2	10^2	± 2%	
Orange	3	3	10^3		
Yellow	4	4	10^4		
Green	5	5	10^5		
Blue	6	6	10^6		
Violet	7	7	10^7		
Grey	8	8	10^8		
White	9	9	10^9		
Salmon					
Pink					Grade 1
None				±20%	

First colour A ....Denotes 1st digit of nominal resistance value.
Second colour B .... Denotes 2nd digit of nominal resistance value.
Third colour C ....Denotes multiplier.
Four colour D .... Denotes selection tolerance.
Fifth colour E .... Denotes grade.

For example, a resistor with first band yellow, second band violet, third band red and fourth band silver is 4.700 Ω ± 10%.

Capacitors

The value of a capacitor is identified by a standard colour code similar to that employed for resistors.



Colour Code: 5 Unit

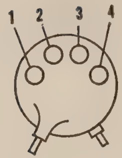
End Colour—Temperature coefficient

1st. Colour—Capacitance in pF

2nd. Colour—Significant figures.

3rd. Colour—Capacitance Multiplier

4th. Colour—Selection Tolerance.



EXAMPLE

End Colour—Violet -750×10^{-6} per deg. C.

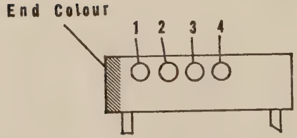
1—Red

2—Violet -270 pF

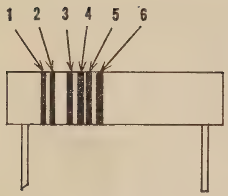
3—Brown

4—Red $- \pm 2\%$.

If no distinct end colour is marked or if this is silver the capacitor has a high permittivity dielectric.



Colour	*Temperature Coefficient (P.P.M./°C)* *End Colour*	*Capacitance (PF)* *1st & 2nd Colour Significant Figure*	*3rd Colour Multiplier*	*Selection Tolerance* *4th Colour* *10 pF or Less*	*More Than 10pF*
Black		0	1	±2·0 pF	±20%
Brown		1	10	±0·1 pF	± 1%
Red		2	100		± 2%
Orange		3	1000	±0·25pF	± 2·5%
Yellow		4	10000		
Green		5		±0·5pF	± 5%
Blue		6			
Violet	N750(−750)	7			
Grey		8	0·01		
White	P100(+100)	9	0·1	±1·0pF	±10%



Colour Code: 6 Unit

1st Colour
2nd Colour —Temperature coefficient
3rd Colour
4th Colour
5th Colour —Capacitance
6th Colour —Tolerance

EXAMPLE

1—Violet —Temperature coefficient
2—Red -750×10^{-6} per deg. C.
3—Brown
4—Green —150 pF.
5—Brown
6—Red — ±2%.

Colour	Temperature Coefficient (P.P.Ml/oC)		Capacitance (PF)		Selection Tolerance	
	1st Colour Significant Figure	2nd Colour Multiplier	3rd & 4th Colour Significant Figure	5th Colour Multiplier	6th Colour 10pF or Under	Over 10 pF
Black	0	1	0	1	±2pF	±20%
Brown	−3	10	1	10		± 1%
Red	−8	100	2	100		± 2%
Orange	−1·5	1000	3	1000	± ·25pF	±2·5%
Yellow	−2·2	10000	4	10000		
Green	− 3·3		5		± ·5pF	± 5%
Blue	−4·7		6			
Violet	−7·5		7			
Grey	+3	·01	8	·01		
White	+1	·1	9	·1	± 1pF	±10%

Commonly Used Waveguide Sizes

British Designation	*RETMA Designation*	*JAN RG/U Brass*	*JAN RG/U Aluminium*	*Inside Dimensions (Inches)*	*Wall Thickness (Inches)*	*Frequency Range Gc/s*	*Attenuation dB/100 ft. (Alum.)*	*Power Rating M.W.*
WG 6	WR 650	69	103	6·500 × 3·250	0·080	1·12 to 1·70	0·28	13·20
WG 8	WR 430	104	105	4·300 × 2·150	0·080	1·70 to 2·60	0·53	5·75
WG 10	WR 284	48	75	2·840 × 1·340	0·080	2·60 to 3·95	1·00	2·50
WG 12	WR 187	49	95	1·872 × 0·872	0·064	3·95 to 5·85	1·85	1·15
WG 14	WR 137	50	106	1·372 × 0·622	0·064	5·85 to 8·20	2·95	0·58
WG 16	WR 90	52	67	0·900 × 0·400	0·050	8·20 to 12·40	5·65	0·25
WG 18	WR 62	91	—	0·622 × 0·311	0·040	1·24 to 18·0	12·76	0·14

Wavelength in a Rectangular Waveguide

The wavelength "λ_g" in a rectangular waveguide whose broad face has an internal width "a" is related to the free space wavelength "λ" by the formula:—

$$\lambda_g = \frac{2a\lambda}{\sqrt{(2a-\lambda)(2a+\lambda)}}$$

For $\lambda = 2a$, λ_g becomes infinite, $2a$ being the so-called cut-off wavelength of the guide. Free space wavelengths of $2a$ and greater cannot be propagated by the waveguide, but will be reflected—not, as often supposed, absorbed. Shorter wavelengths corresponding to higher frequencies than those recommended in the above table can be propagated in more than one waveguide mode, and so give rise to serious mismatch problems.

Squint of Linear Waveguide Arrays

The angle of squint of a slotted waveguide aerial, measured from the normal to the waveguide, is given by the formula

$$\sin\theta = \frac{\lambda}{\lambda_g} - \frac{\lambda}{2S}$$

Here S is the distance between the centre of adjacent slots, and if, as usual, S is greater than $\lambda_g/2$, the squint is towards the end load of the array.

Microwave Aerial Gain

A good guide to the practically achievable gain of a microwave aerial is given by $G = \frac{2\pi A}{\lambda^2}$, where A is the area of the aerial (e.g. reflector or horn aperture) in the same units as the wavelength λ. In the case of aerials with specially shaped beams, however, the gain will be lower; e.g. typical "cosecant²" radar aerials have from 2 dB to 6 dB less gain than their areas suggest.

Table showing relation between Decibels, Current and Voltage Ratio and Power Ratio

$$dB = 10 \log \frac{P_1}{P_2} = 20 \log \frac{V_1}{V_2} = 20 \log \frac{I_1}{I_2}$$

dB	I_1/I_2 or V_1/V_2	I_2/I_1 or V_2/V_1	P_1/P_2	P_2/P_1	dB	I_1/I_2 or V_1/V_2	I_2/I_1 or V_2/V_1	P_1/P_2	P_2/P_1
0.1	1.012	.989	1.023	.977	15.0	5.62	.178	31.6	.0316
0.2	1.023	.977	1.047	.955	15.5	5.96	.168	35.5	.0282
0.3	1.035	.966	1.072	.933	16.0	6.31	.158	39.8	.0251
0.4	1.047	.955	1.096	.912	16.5	6.68	.150	44.7	.0224
0.5	1.059	.944	1.122	.891	17.0	7.08	.141	50.1	.0200
0.6	1.072	.933	1.148	.871	17.5	7.50	.133	56.2	.0178
0.7	1.084	.923	1.175	.851	18.0	7.94	.126	63.1	.0158
0.8	1.096	.912	1.202	.832	18.5	8.41	.119	70.8	.0141
0.9	1.109	.902	1.230	.813	19.0	8.91	.112	79.4	.0126
1.0	1.122	.891	1.259	.794	19.5	9.44	.106	89.1	.0112
1.1	1.135	.881	1.288	.776	20.0	10.00	.1000	100.	.0100
1.2	1.148	.871	1.318	.759	20.5	10.59	.0944	112.	.00891
1.3	1.162	.861	1.349	.741	21.0	11.22	.0891	126.	.00794
1.4	1.175	.851	1.380	.724	21.5	11.88	.0841	141.	.00708
1.5	1.188	.841	1.413	.708	22.0	12.59	.0794	158.	.00631
1.6	1.202	.832	1.445	.692	22.5	13.34	.0750	178.	.00562
1.7	1.216	.822	1.479	.676	23.0	14.13	.0708	200.	.00501
1.8	1.230	.813	1.514	.661	23.5	14.96	.0668	224.	.00447
1.9	1.245	.804	1.549	.645	24.0	15.85	.0631	251.	.00398
2.0	1.259	.794	1.585	.631	24.5	16.79	.0596	282.	.00355
2.5	1.334	.750	1.778	.562	25.0	17.78	.0562	316.	.00316
3.0	1.413	.708	1.995	.501	25.5	18.84	.0531	355.	.00282
3.5	1.496	.668	2.24	.447	26.0	19.95	.0501	398.	.00251
4.0	1.585	.631	2.51	.398	26.5	21.1	.0473	447.	.00224
4.5	1.679	.596	2.82	.355	27.0	22.4	.0447	501.	.00200
5.0	1.778	.562	3.16	.316	27.5	23.7	.0422	562.	.00178
5.5	1.884	.531	3.55	.282	28.0	25.1	.0398	631.	.00158
6.0	1.995	.501	3.98	.251	28.5	26.6	.0376	708.	.00141
6.5	2.11	.473	4.47	.224	29.0	28.2	.0355	794.	.00126
7.0	2.24	.447	5.01	.200	29.5	29.8	.0335	891.	.00112
7.5	2.37	.422	5.62	.178	30.0	31.6	.0316	1,000.	.00100
8.0	2.51	.398	6.31	.158	31.0	35.5	.0282	1,260.	$7.94 \cdot 10^{-4}$
8.5	2.66	.376	7.08	.141	32.0	39.8	.0251	1,580.	$6.31 \cdot 10^{-4}$
9.0	2.82	.355	7.94	.126	33.0	44.7	.0224	2,000.	$5.01 \cdot 10^{-4}$
9.5	2.98	.335	8.91	.112	34.0	50.1	.0200	2,510.	$3.98 \cdot 10^{-4}$
10.0	3.16	.316	10.00	.100	35.0	56.2	.0178	3,160.	$3.16 \cdot 10^{-4}$
10.5	3.35	.298	11.2	.0891	36.0	63.1	.0158	3,980.	$2.51 \cdot 10^{-4}$
11.0	3.55	.282	12.6	.0794	37.0	70.8	.0141	5,010.	$2.00 \cdot 10^{-4}$
11.5	3.76	.266	14.1	.0708	38.0	79.4	.0126	6,310.	$1.58 \cdot 10^{-4}$
12.0	3.98	.251	15.8	.0631	39.0	89.1	.0112	7,940.	$1.26 \cdot 10^{-4}$
12.5	4.22	.237	17.8	.0562	40.0	100.0	.0100	$1.00 \cdot 10^{4}$	$1.00 \cdot 10^{-4}$
13.0	4.47	.224	20.0	.0501	50.0	316.0	.00316	$1.00 \cdot 10^{5}$	$1.00 \cdot 10^{-5}$
13.5	4.73	.211	22.4	.0447	60.0	1,000.0	.00100	$1.00 \cdot 10^{6}$	$1.00 \cdot 10^{-6}$
14.0	5.01	.200	25.1	.0398	70.0	3,160.0	.00032	$1.00 \cdot 10^{7}$	$1.00 \cdot 10^{-7}$
14.5	5.31	.188	28.2	.0355	80.0	10,000.0	.00010	$1.00 \cdot 10^{8}$	$1.00 \cdot 10^{-8}$

Propagation Formulae

Free Space Field

In the equatorial plane of a Half-wave Dipole, the field in Free Space is

$$\frac{7{\cdot}02\sqrt{P}}{D} \text{ volts per metre}$$

where:—

P = transmitted power, watts into the Half-wave Dipole.

D = distance, metres.

For 1 kW radiated, the Free Space field is

$$\frac{222}{D} \text{ volts per metre.}$$

Input Voltage to Matched Receiver fed by a Half-Wave Dipole is

$$\frac{E\lambda}{2\pi} \text{ volts (ignoring feeder loss),}$$

where:—

E = received field strength, volts per metre,

λ = wavelength, metres.

Path Attenuation in Free Space between Half-Wave Dipoles is

$$18+20 \log_{10} \frac{D}{\lambda} \text{ dB}$$

where:—

D = distance,

λ = wavelength (in same units).

Path Attenuation in Free Space between Isotropic Aerials is

$$22+20 \log_{10} \frac{D}{\lambda} \text{ dB}$$

Relation between Field Strength and Power Flux

$E = \sqrt{Z_0 S}$ volts per metre

where:—

E = field strength, volts per metre,

S = power flux, watts per sq. metre,

Z_0 = impedance of free space = 120π ohms.

Fresnel Reflection Coefficients

The complex coefficient for reflection at an infinite plane surface is given by

$$\rho = \frac{\zeta \sin \theta - 1}{\zeta \sin \theta + 1}$$

where θ is the grazing angle of reflection and ζ is as defined below.

For the electric vector perpendicular to the plane of incidence ("horizontal" polarisation)

$$\zeta = \frac{1}{\sqrt{k - 60i\sigma\lambda - \cos^2\theta}}$$

For the electric vector in the plane of incidence ("vertical" polarisation)

$$\zeta = \frac{k - 60i\sigma\lambda}{\sqrt{k - 60i\sigma\lambda - \cos^2\theta}}$$

where, for both polarisations:—

k is the dielectric constant of the surface,

σ is the conductivity of the surface, mhos per metre,

λ is the wavelength, metres,

$i = \sqrt{-1}$ and a positive time factor is assumed.

Representative Values of k and σ

Surface	*Dielectric Constant, k*	*Conductivity, σ mhos per metre*
Dry Ground	5	5×10^{-4}
Average Ground	10	5×10^{-3}
Wet Ground	20	5×10^{-2}
Sea Water	80	4

Path Difference between Ground-Reflected and Direct Ray Paths over a Flat Earth is

$$\frac{2h_1h_2}{D}$$

where:—

h_1 and h_2 are the respective aerial heights above ground level, D is the distance in the same units, and h_1 and $h_2 \ll D$.

Horizon Distance is approximately given by

$$\sqrt{2HR}$$

where:—

H = aerial height above sea level,

R = earth radius (in same units), modified if required to allow for atmospheric refraction.

For a True Earth radius the Horizon Distance is

$$\sqrt{1{\cdot}5H} \text{ statute miles,}$$

where H is expressed in feet,

or $3{\cdot}57\sqrt{H}$ km,

where H is expressed in metres.

Using a "4/3 Earth" radius to allow for standard atmospheric refraction. The Radio Horizon Distance is

$$\sqrt{2H} \text{ statute miles,}$$

where H is expressed in feet,

or $4{\cdot}12\sqrt{H}$ km,

where H is expressed in metres.

Knife-Edge Diffraction Loss

For a "knife-edge" blocking the line of sight by a height h, situated at distances a and b from the respective radio terminals, the obstruction loss at a wavelength λ is

$$13+10\log_{10}\left[\frac{2(a+b)}{ab\lambda}\right]\text{ dB}$$

with respect to free space so long as

$$\frac{2(a+b)\,h^2}{ab\lambda} > 1$$

First Fresnel Zone Clearance of a Knife-Edge is

$$\sqrt{\frac{ab\lambda}{a+b}}$$

in the above notation, where a, b and λ are in the same units.

Diffraction Loss beyond the Horizon

Sufficiently far beyond the horizon, the field at a wavelength λ decreases at the rate of

$$25{\cdot}7\,[\lambda\, R_m^2]^{-1/3}\text{ dB per km,}$$

where R_m is a Modified Earth Radius expressed in km, appropriate to the prevailing atmospheric refraction, and λ is the wavelength in km.

Gain of Large-Aperture Aerials is

$$10\log_{10}\left[\frac{4\pi A}{\lambda^2}\right]\text{ dB}$$

with respect to an isotropic aerial,

where:—

λ is the wavelength in metres,

A is the effective area of the aperture in sq. metres, which will amount to only about 60% of the actual area due to non-uniform illumination.

Beam-width of Large-Aperture Aerials is

$$\frac{69\lambda}{a}\text{ for 3 dB loss,}$$

$$\text{and }\frac{100\lambda}{a}\text{ for 6 dB loss,}$$

where a is the width of the relevant aperture in metres.

Attenuation between Identical Large-Aperture Aerials is

$$20\log_{10}\left[\frac{\lambda D}{A}\right]\text{ dB}$$

where:—

D is the separation between aerials in metres, assumed much greater than the Rayleigh Range,

A is the effective area of each aperture in sq. metres, as previously specified.

Rayleigh Range of a Large Aperture Aerial is

$$\frac{a^2}{2\lambda}$$

where:—

a is the relevant aerial aperture,

λ is the wavelength in the same units.

Effective Area of a Half-Wave Dipole is

$$0{\cdot}13\ \lambda^2 \text{ sq. metres.}$$

Radio Refractive Index is customarily expressed in units of $(n\text{-}1)10^6$ or "*N* units", where n is the actual refractive index.

Modified Refractive Index is

$$10^6\left[n-1+\frac{h}{R_0}\right]\ M \text{ units}$$

$$=\left[N+\frac{10^6 h}{R_0}\right]\ M \text{ units}$$

where:—

h = height above the earth, metres,

R_0 = the True Earth Radius

= $6{\cdot}37\times 10^6$ metres.

Modified Refractive Index Gradient (or *M* Gradient) is given by

$$\frac{dM}{dh}=10^6\left[\frac{dn}{dh}+\frac{1}{R_0}\right]\ M \text{ units per metre}$$

where $\frac{dn}{dh}$ is the Refractive Index Gradient

The Effective Earth Radius Factor is given by

$$k=\frac{R_m}{R}$$

$$=\frac{10^6}{R_0\, dM/dh}$$

where:—

R_m is a Modified Earth Radius (expressed in metres), which from the propagation stand point allows for the influence of atmospheric refraction,
R_0 = the True Earth Radius in metres.

For a Standard Atmosphere:—

$$k=\frac{4}{3},$$

$$\frac{dn}{dh}=-0{\cdot}039\ N \text{ units per metre,}$$

$$\frac{dM}{dh}=0{\cdot}12\ M \text{ units per metre.}$$

Trapping in a Tropospheric Radio Duct occurs when the wavelength is less than

$$\frac{d}{400}\sqrt{\Delta M}\ \text{ metres}$$

where:—

d is the duct thickness, metres,

ΔM is the change in Modified Refractive Index (*M* units) across the duct.

Plasma Frequency of Ionisation

$$f_N = \sqrt{\frac{Ne^2}{\pi m}}$$

where:—
N is the ion density
e is the charge
and m is the mass of a charged particle.

Gyro Frequency of charged particles in a magnetic field

$$f_H = \frac{He}{2\pi m}$$

where:—
H is the magnetic field strength
e is the charge
and m is the mass of a charged particle.

Appleton—Hartree equation for the refractive index of an ionised medium in the presence of a magnetic field, neglecting collisions

$$\mu = \sqrt{1 - \frac{f_N^2/f^2}{1 - \frac{f_T^2/f^2}{2(1-f_N^2/f^2)} \pm \sqrt{\frac{f_T^4/f^4}{4(1-f_N^2/f^2)^2} + \frac{f_L^2}{f^2}}}}$$

where:—
f is the wave frequency
f_N is the plasma frequency
$f_T = f_H \sin\theta$
$f_L = f_H \cos\theta$
θ is the angle between the direction of propagation and the magnetic field, in the ionised medium,
f_H is the gyro frequency.

The critical frequency of an ionised layer is the highest frequency which will be reflected by the layer at vertical incidence and is the frequency for which $\mu = 0$ at the level of maximum ionisation.

In the presence of a magnetic field there are usually 2 critical frequencies related as:

$$f_x^2 - f_o^2 = f_x f_H$$

where:—
f_o is the critical frequency of the ordinary mode
and
f_x is the critical frequency of the extraordinary mode.

When f_x and f_o are much greater than f_H, the usual case at h.f., then:

$$f_x - f_o = \frac{f_H}{2}$$

The ordinary mode critical frequency, f_o, is equal to the plasma frequency at the level of maximum ionisation, $(f_N)_{max}$.

The oblique incidence maximum usable frequency, f_{ob}, is related to the critical frequency at vertical incidence, f_r, assuming a plane earth and ionosphere and no magnetic field by

$$f_{ob} = f_r \sec\phi$$

where ϕ is the angle of incidence of the oblique wave upon the layer.

Chapman Layer

The electron distribution in a plane stratified ionosphere assuming the atmospheric density is proportional to $\exp(-z)$ is

$$N = N_o \exp\left(\frac{1-z-e^{-z}\sec\chi}{2}\right)$$

where:—

N_o is the electron density at the height where $z = 0$

z is the height, normalised by the scale height H, and is zero at the height of the layer maximum when $\chi = 0$

χ is the solar zenith distance

Scale Height is

$$H = \frac{kT}{mg}$$

where:—

k is Boltzmann's constant ($1{\cdot}38\times 10^{-16}$ erg/degree)

T is the absolute temperature

m is the mean molecular mass of the gas

and

g is the acceleration due to gravity

Spherical Triangles

1. Distance

$$\cos\chi = \sin\phi\sin\delta + \cos\phi\cos\delta\cos H$$

where:—

ϕ is the latitude of the observing point

δ is the latitude of the other location OR the declination of the star

H is the difference in longitude between the locations OR the local hour angle of the star

and

χ is the distance between the locations OR the zenith distance of the star.

distance in minutes of arc = distance in nautical miles

1 nautical mile = 1·152 statute miles = 6080 ft = 1·852 km.

2. Azimuth

$$\sin z = \cos\delta\,\mathrm{cosec}\,\chi\sin H$$

where:—

z is the azimuth east or west of north

3. Azimuth Without Tables

$$\sin z = -\frac{dH}{dt}\,\mathrm{Sec}\,\phi$$

$$\text{or } \sin z = \frac{H_2'' - H_1''}{15t}\,\mathrm{Sec}\,\phi$$

The Elevation H, and H^2 of a body, in seconds of arc, is observed to an interval of t sec time.

ϕ = latitude

z = Azimuth of body (Mean of interval t)

The Radar Equation

This relates the peak range of a radar equipment R to the parameters of the equipment, and may be written

$$R^4 = \frac{P.a\,.\,\lambda^2\,G^2}{P_m.\,(4\pi)^3}$$

Here:— P = Peak pulse power
a = Target echoing area
λ = Wavelength
G = Aerial gain
P_m = Minimum detectable signal

This formula is not, however, of immediate practical use, chiefly because actual targets fluctuate, e.g. aircraft have echoing areas which vary by a factor of 10 or more with changes of aspect, vertically or horizontally, so a is only a mean figure, which is also a function of the wavelength and polarization of the radar.

P_m is obviously directly related to the noise factor of the radar receiver, but also depends on the display characteristics, including the operator. Since a is fluctuating P_m must be related to a stated probability of detection, and is also a function of the number of pulses which fall on the target as the radar beam sweeps through it. Even G depends in certain conditions upon lobes formed by energy reflected from the ground, and in long range equipments the losses due to atmospheric attenuation cannot be neglected. Hence it is unsafe to use the radar equation alone to predict performance, and care must be used in scaling from one equipment to another, usually permissible where the wavelengths are almost identical, and for similar targets. It is, however useful for calculating by how much a change in a given parameter (such as transmitter power or receiver noise factor) will affect the performance of a given radar.

Transmission Lines and Coaxial Cables

For air spaced concentric line

$Z_o = 138 \log_{10} \frac{r_2}{r_1}$ ohms where r_1, r_2 are inner and outer radii

For air spaced twin line

$Z_o = 276 \log_{10} \frac{d}{r}$, where d is spacing and r radius of lines

For flexible, copper braid sheathed, solid dielectric coaxial R.F. cables, the following data apply.

Type	$Z_o(\Omega)$	dBs/100 ft		*Maximum overall diameter (ins.)*
		100 *Mc/s*	600 *Mc/s*	
UR43	52	4·33	13·7	0·200
UR67	50	2·02	5·52	0·415
UR74	51	0·97	2·96	0·890
UR17	71	1·07	3·83	1·020
UR39	69	2·56	7·94	0·320
UR70	72	4·65	13·42	0·240
UR37	75	1·89	5·23	0·415
UR77	75	0·98	2·98	0·885

Radio Frequency Allocations

EUROPEAN ZONE (GENEVA 1959)

Frequency kHz	Fixed	Mobile	Land Mobile	Maritime Mobile	Aeronautical Mobile	Amateur	Broadcasting	Meteorological	Radio Navigation	Radio Location	Standard Frequency	Space	Radio Astronomy
10—14									X	X			
14—20	X			X									
20											X		
20—70	X			X									
70—72									X				
72—84	X			X					X				
84—86									X				
86—112	X			X					X				
112—115									X				
115—126	X			X					X				
126—129									X				
129—130	X			X					X				
130—150	X			X									
150—160				X			X						
160—255							X						
255—285				X			X		X				
285—325									X				
325—405					X				X				
405—415			X	X					X				
415—490				X									
490—510		X											
510—525				X					X				
525—1605							X						
1605—2045	X		X	X									
2045—2065	X		X	X				X					
2065—2170	X	X											
2170—2194		X											
2194—2300	X	X											
2300—2500	X	X					X						
2500											X		
2500—2625	X	X											
2625—2650				X					X				
2650—2850	X	X											
2850—3155					X								
3155—3200	X	X											
3200—3230	X	X					X						

Frequency kHz	Fixed	Mobile	Land Mobile	Maritime Mobile	Aeronautical Mobile	Amateur	Broadcasting	Meteorological	Radio Navigation	Radio Location	Standard Frequency	Space	Radio Astronomy
3230—3400	X		X	X			X						
3400—3500					X								
3500—3800	X		X	X		X							
3800—3900	X		X		X								
3900—3950					X								
3950—4000	X						X						
4000—4063	X												
4063—4438				X									
4438—4650	X	X											
4650—4750					X								
4750—4850	X		X		X		X						
4850—5000	X		X				X						
5000													
5000—5060	X						X						
5060—5250	X												
5250—5430	X		X										
5430—5480	X		X		X								
5480—5730					X								
5730—5950	X												
5950—6200							X						
6200—6525				X									
6525—6765					X								
6765—7000	X												
7000—7100						X							
7100—7300							X						
7300—8195	X												
8195—8815				X									
8815—9040					X								
9040—9500	X												
9500—9775							X						
9775—10,000	X												
10,000											X		
10,000—10,100					X								
20,100—11,175	X												
11,175—11,400					X								
11,400—11,700	X												
11,700—11,975							X						
11,975—12,330	X												
12,330—13,200				X									

Frequency kHz	Fixed	Mobile	Land Mobile	Maritime Mobile	Aeronautical Mobile	Amateur	Broadcasting	Meteorological	Radio Navigation	Radio Location	Standard Frequency	Space	Radio Astronomy
13,200—13,360					X								
13,360—14,000	X												
14,000—14,350						X							
14,350—15,000	X												
15,000											X		
15,000—15,100					X								
15,100—15,450							X						
15,450—16,460	X												
16,460—17,360				X									
17,360—17,700	X												
17,700—17,900							X						
17,900—18,030					X								
18,030—20,000	X												
20,000											X		
20,000—21,000	X												
21,000—21,450						X							
21,450—21,750							X						
21,750—21,850	X												
21,850—22,000	X				X								
22,000—22,720				X									
22,720—23,200	X												
23,200—23,350	X				X								
23,350—24,000	X		X	X									
24,000—25,000	X		X										
25,000											X		
25,000—25,070	X		X	X									
25,070—25,110				X									
25,110—25,600	X		X	X									
25,600—26,100							X						
26,100—27,500	X		X	X									
27,500—28,000								X					

Frequency MHz	Fixed	Mobile	Land Mobile	Maritime Mobile	Aeronautical Mobile	Amateur	Broadcasting	Meteorological	Radio Navigation	Radio Location	Standard Frequency	Space	Radio Astronomy
28—29·7						X							
29·7—41	X	X											
41—47	X	X					X						
47—68							X						
68—74·8	X		X	X									
74·8—75·2									X				
75·2—87·5	X		X	X									
87·5—100							X						
100—108		X											
108—118									X				
118—136					X								
136—137	X	X										X	
137—144					X								
144—146						X							
146—151	X	X											
151—154	X	X						X					
154—156	X	X											
156—174	X		X	X									
174—216							X						
216—223							X		X				
223—235	X	X							X				
235—328·6	X	X											
328·6—335·4									X				
335·4—400	X	X											
400—401								X				X	
401—406	X		X	X				X					
406—420	X		X	X									
420—430	X		X	X						X			
430—440						X				X			
440—450	X		X	X						X			
450—470	X	X											
470—582							X						
582—606							X		X				
606—790							X						
790—890	X						X						
890—942	X						X			X			
942—960	X						X						
960—1215									X				

Frequency MHz	Fixed	Mobile	Land Mobile	Maritime Mobile	Aeronautical Mobile	Amateur	Broadcasting	Meteorological	Radio Navigation	Radio Location	Standard Frequency	Space	Radio Astronomy
1215—1300						X				X			
1300—1350									X	X			
1350—1400	X	X								X			
1400—1427													X
1427—1429	X		X	X								X	
1429—1535	X		X	X									
1535—1660									X				
1660—1700	X		X	X				X					
1700—1710	X	X										X	
1710—2290	X	X											
2290—2300	X	X										X	
2300—2450	X	X				X				X			
2450—2550	X	X								X			
2550—2700	X	X											
2700—3100									X	X			
3100—3400										X			
3400—3600	X	X								X			
3600—4200	X	X											
4200—4400									X				
4400—5000	X	X											
5000—5250									X				
5250—5255										X		X	
5255—5350										X			
5350—5650									X	X			
5650—5850						X				X			
5850—8400	X	X											
8400—8500	X	X										X	
8500—8750										X			
8750—8850									X	X			
8850—9000										X			
9000—9200									X	X			
9200—9300										X			
9300—9500									X	X			
9500—9800										X			
9800—10,000	X									X			
10,000—10,500						X				X			
10,500—10,700	X	X								X			
10,700—11,700	X	X											
11,700—12,700	X		X	X			X						
12,700—13,250	X	X											

Frequency MHz	Fixed	Mobile	Land Mobile	Maritime Mobile	Aeronautical Mobile	Amateur	Broadcasting	Meteorological	Radio Navigation	Radio Location	Standard Frequency	Space	Radio Astronomy
13,250—13,400									X				
13,400—14,000										X			
14,000—14,400									X				
14,400—15,150	X	X											
15,150—15,250	X	X										X	
15,250—15,400	X	X											
15,400—15,700									X				
15,700—17,700										X			
17,700—21,000	X	X											
21,000—22,000						X							
22,000—23,000	X	X											
23,000—24,250										X			
24,250—25,250									X				
25,250—31,500	X	X											
31,500—31,800	X	X										X	
31,800—33,400									X				
33,400—36,000										X			
36,000—40,000	X	X											
40,000	Not allocated.												

Characteristics of Television Systems

(As indicated in C.C.I.R. Report 308, Xth Plenary Assembly, Geneva. 1963)

System	*Number of Lines*	*Channel Width MHz*	*Vision Band-width MHz*	*Vision/Sound Separa-tion MHz*	*Vestigial Side-band MHz*	*Vision Modula-tion*	*Sound Modula-tion*
A	405	5	3	— 3·5	0·75	Pos	AM
B	625	7	5	+ 5·5	0·75	Neg	FM
C	625	7	5	+ 5·5	0·75	Pos	AM
D	625	8	6	+ 6·5	0·75	Neg	FM
E	819	14	10	±11·5	2	Pos	AM
F	819	7	5	+ 5·5	0·75	Pos	AM
G	625	8	5	+ 5·5	0·75	Neg	FM
H	625	8	5	+ 5·5	1·25	Neg	FM
I	625	8	5·5	+ 6	1·25	Neg	FM
K	625	8	6	+ 6·5	0·75	Neg	FM
K^1	625	4	6	+ 6·5	1·25	Neg	FM
L	625	8	6	+ 6·5	1·25	Pos	AM
M	625	6	4·2	+ 4·5	0·75	Neg	FM
N	625	6	4·2	+ 4·5	0·75	Neg	FM

United Kingdom (U.K.): System A. 405 Lines

Ch.	*MHz*	*Ch.*	*MHz*	*Ch.*	*MHz*
1	45·00/41·50	6	179·75/176·25	11	204·75/201·25
2	51·75/48·25	7	184·75/181·25	12	209·75/206·25
3	56·75/53·25	8	189·75/186·25	13	214·75/211·25
4	61·75/58·25	9	194·75/191·25	14	219·75/216·25
5	66·75/63·25	10	199·75/196·25		

System I. 625 Lines

Ch.	*MHz*	*Ch.*	*MHz*	*Ch.*	*MHz*	*Ch.*	*MHz*
21	471·25/477·25	33	567·25/573·25	45	663·25/669·25	57	759·25/765·25
22	479·25/485·25	34	575·25/581·25	46	671·25/677·25	58	767·25/773·25
23	487·25/493·25	35	583·25/589·25	47	679·25/685·25	59	775·25/781·25
24	495·25/501·25	36	591·25/597·25	48	687·25/693·25	60	783·25/789·25
25	503·25/509·25	37	599·25/605·25	49	695·25/701·25	61	791·25/797·25
26	511·25/517·25	38	607·25/613·25	50	703·25/709·25	62	799·25/805·25
27	519·25/525·25	39	615·25/621·25	51	711·25/717·25	63	807·25/813·25
28	527·25/533·25	40	623·25/629·25	52	719·25/725·25	64	815·25/821·25
29	535·25/541·25	41	631·25/637·25	53	727·25/733·25	65	823·25/829·25
30	543·25/549·25	42	639·25/645·25	54	735·25/741·25	66	831·25/837·25
31	551·25/557·25	43	647·25/653·25	55	743·25/749·25	67	839·25/845·25
32	559·25/565·25	44	655·25/661·25	56	751·25/757·25	68	847·25/853·25

Autoplex Code Conversion

Combination No.	Figure Case	Letter Case	5-Unit Code:– Start Polarity ○ Stop Polarity ●	7-Unit Code :— ● Z Element ○ A Element
1	—	A	● ● ○ ○ ○	○ ○ ● ● ○ ● ○
2	?	B	● ○ ○ ● ●	○ ○ ● ● ○ ○ ●
3	:	C	○ ● ● ● ○	● ○ ○ ● ● ○ ○
4	* Who are you?	D	● ○ ○ ● ○	○ ○ ● ● ● ○ ○
5	3	E	● ○ ○ ○ ○	○ ● ● ● ○ ○ ○
6	* %	F	● ○ ● ● ○	○ ○ ● ○ ○ ● ●
7	* @	G	○ ● ○ ● ●	● ● ○ ○ ○ ○ ●
8	* £	H	○ ○ ● ○ ●	● ○ ● ○ ○ ● ○
9	8	I	○ ● ● ○ ○	● ● ● ○ ○ ○ ○
10	Bell	J	● ● ○ ● ○	○ ● ○ ○ ○ ● ●
11	(	K	● ● ● ● ○	○ ○ ○ ● ○ ● ●
12	)	L	○ ● ○ ○ ●	● ● ○ ○ ○ ● ○
13	.	M	○ ○ ● ● ●	● ○ ● ○ ○ ○ ●
14	,	N	○ ○ ● ● ○	● ○ ● ○ ● ○ ○
15	9	O	○ ○ ○ ● ●	● ○ ○ ○ ● ● ○
16	0	P	○ ● ● ○ ●	● ○ ○ ● ○ ● ○
17	1	Q	● ● ● ○ ●	○ ○ ○ ● ● ○ ●
18	4	R	○ ● ○ ● ○	● ● ○ ○ ● ○ ○
19	′	S	● ○ ● ○ ○	○ ● ○ ● ○ ● ○
20	5	T	○ ○ ○ ○ ●	● ○ ○ ○ ● ○ ●
21	7	U	● ● ● ○ ○	○ ● ● ○ ○ ● ○
22	=	V	○ ● ● ● ●	● ○ ○ ● ○ ○ ●
23	2	W	● ● ○ ○ ●	○ ● ○ ○ ● ○ ●
24	/	X	● ○ ● ● ●	○ ○ ● ○ ● ● ○
25	6	Y	● ○ ● ○ ●	○ ○ ● ○ ● ○ ●
26	+	Z	● ○ ○ ○ ●	○ ● ● ○ ○ ○ ●
27	Carriage return		○ ○ ○ ● ○	● ○ ○ ○ ○ ● ●
28	Line feed		○ ● ○ ○ ○	● ○ ● ● ○ ○ ○
29	Figure shift		● ● ○ ● ●	○ ● ○ ○ ● ● ○
30	Letter shift		● ● ● ● ●	○ ○ ○ ● ● ● ○
31	Space		○ ○ ● ○ ○	● ● ○ ● ○ ○ ○
32	Unperforated tape (*Error symbol)		○ ○ ○ ○ ○	○ ○ ○ ○ ● ● ●
	RQ signal			○ ● ● ○ ● ○ ○
	Idle Alpha signal		(normally continuous start polarity)	○ ● ○ ● ○ ○ ●
	Idle Beta signal		(normally continous stop polarity)	○ ● ○ ● ● ○ ○
	* Optional			

Definition of 8-Channel KDF9/MYRIAD Version of ISO Code (A) and American Standard Code for Information Interchange (ASCII) (B) (Teletype)

Octal	*Character (A)*	*Character (B)*	*Octal*	*Character (A)*	*Character (B)*
000	Blank	Blank	300	Underline	@
201	Not used	SOM	101	A	A
202	Not used	EOA	102	B	B
003	Not used	EOM	303	C	C
204	Not used	EOT	104	D	D
005	Not used	WRU	305	E	E
006	Not used	RU	306	F	F
207	Not used	Bell	107	G	G
210	Not used	FEo	110	H	H
011	Tabulate	H. Tab	311	I	I
012	Line Feed	Line Feed	312	J	J
213	Not used	V. Tab	113	K	K
014	Not used	Form	314	L	L
215	Carr. Ret.	Carr. Ret.	115	M	M
216	Not used	SO	116	N	N
017	Not used	SI	317	O	O
220	Not used	DCo	120	P	P
021	Not used	X–ON	321	Q	Q
022	Not used	aux. on	322	R	R
223	Not used	X–OFF	123	S	S
024	Not used	aux. off	324	T	T
225	Not used	Error	125	U	U
226	Not used	Sync	126	V	V
027	Not used	LEM	327	W	W
030	Not used	So	330	X	X
231	Not used	Sl	131	Y	Y
232	Not used	S2	132	Z	Z
033	Not used	S3	333	[	[
234	Not used	S4	134	£	\
035	Not used	S5	335	]	]
036	Not used	S6	336	↑	↑
237	Not used	S7	137	←	←

Octal	*Character (A)*	*Character (B)*	*Octal*	*Character (A)*	*Character (B)*
240	Space	Space	140	@	Not used
041	!	!	341	a	Not used
042	"	"	342	b	Not used
243	½	#	143	c	Not used
044	$	$	344	d	Not used
245	%	%	145	e	Not used
246	&	&	146	f	Not used
047	?	'	347	g	Not used
050	(	(	350	h	Not used
251	)	)	151	i	Not used
252	*	*	152	j	Not used
053	+	+	353	k	Not used
254	,	,	154	l	Not used
055	—	—	355	m	Not used
056	.	.	356	n	Not used
257	/	/	157	o	Not used
060	0	0	360	p	Not used
261	1	1	161	q	Not used
262	2	2	162	r	Not used
063	3	3	363	s	Not used
264	4	4	164	t	Not used
065	5	5	365	u	Not used
066	6	6	366	v	Not used
267	7	7	167	w	Not used
270	8	8	170	x	Not used
071	9	9	371	y	Not used
072	:	:	372	z	Not used
273	;	;	173	Not used	Not used
074	<	<	374	Not used	ACK
275	=	=	175	Not used	Alt. Mode
276	>	>	176	Not used	Escape
077	10	?	377	Delete	Delete

These codes are of even parity, the parity bit appearing in channel 8. The sprocket hole lies between channels 3 and 4.

Flexowriter Code Specification

Octal No.	*Symbol*	
006	/SHIFT	
017	/	:
022	CR/LF	
024	TAB	
027	NORMAL	
041	1	[
042	2	]
044	4	>
047	7	÷
050	8	(
053	$_{10}$	£
055	+	≠
056	−	*
060	0	↑
063	3	<
065	5	=
066	6	×
071	9	)
072	—	—
074	;	;
077	.	
101	A	
102	B	
104	D	
107	G	
110	H	
113	K	
115	M	
116	N	
123	C	
125	E	
126	F	
131	I	
132	J	
134	L	
137	O	
140	P	
143	S	
145	U	
146	V	
151	Y	
152	Z	
161	Q	
162	R	
164	T	
167	W	
170	X	
175	→	→
176	ESCAPE	
220	SPACE	
377	ERASE	
000	BLANK TAPE	

Myriad Order Code

User Code	*M/c Code*	*Function*	*Effect*		
			A	*B*	*N*
ENTR	05	Input to N	—	—	Input
EXIT	07	Output from N	—	—	—
ADDR	06	Output address from N	—	—	—
SETA	10	Fetch (N) to A	(N)	—	—
ADDA	11	Add (N) to (A)	(A) + (N)	—	—
SUBA	13	Subtract (N) from (A)	(A) − (N)	—	—
STRA	12	Store (A) in N	—	—	(A)
EXCA	30	Exchange (A) and (N)	(N)	—	(A)
ANDA	21	Collate (N) with (A)	(A) & (N)	—	—
NEQA	23	Not Equivalent (N) with (A	(A)$\not\equiv$(N)	—	—
NEGA	24	Complement (A)	− (A)	—	—
NEGB	20	Complement (B)	—	− (B)	—
SETB	14	Fetch (N) to B	—	(N)	—
ADDB	15	Add (N) to (B)	—	(B) + (N)	—
SUBB	17	Subtract (N) from (B)	—	(B) − (N)	—
STRB	16	Store (B) in N	—	—	(B)
EXCB	32	Exchange (B) and (N)	—	(N)	(B)
ANDB	25	Collate (N) with (A)	—	(B)&(N)	—
NEQB	27	Not Equivalent (N) with (A		(B)$\not\equiv$(N)	—
ADDX	35	Add (N) to (AB)	(A) + C	(B) + (N)	—
SUBX	37	Subtract (N) from (AB)	(A) − C	(B) − (N)	—
ZERO	31	Clear N	—	—	O
SHLA	60	Shift (A) left N places	$(A).2^{N}$	—	—
SHRA	61	Shift (A) right N places	$(A).2^{-N}$	—	—
SHLB	64	Shift (B) left N places	—	$(B).2^{N}$	—
SHRB	65	Shift (B) right N places	—	$(B).2^{-N}$	—
SHLX	66	Shift (AB) left N places	$(AB).2^{N}$		—
SHRX	63	Shift (AB) right N places	$(AB).2^{-N}$		—
CSHF	62	Shift (A) left until a one overspills	Remainder after 1 overspills	No. of shifts performed	—

continued overleaf

User Code	M/c Code	Function	Effect		
			A	B	N
JUMP	40	Jump to N	—	—	—
JNNA	41	Jump to N if (A) $\geqq 0$	—	—	—
JEZA	42	Jump to N if (A)$=0$	—	—	—
JNPA	43	Jump to N if (A)<0	—	—	—
JNNB	45	Jump to N if (B)$\geqq 0$	—	—	—
JEZB	46	Jump to N if (B)$=0$	—	—	—
JNPB	47	Jump to N if (B)<0	—	—	—
JSNS	44	Jump to N if Sign Change Trigger Not Set	—	—	—
LINK	50	Link to N	—	—	—
LOFL	52	Link to N if Overflow Trigger Set	—	—	—
LSCS	53	Link to N if Sign Change Trigger Set	—	—	—
LAFL	51	Link to N if Address Failure Trigger Set*	—	—	—
SETP	02	Set Prohibitions	—	—	—
CLRP	03	Clear Prohibitions*	—	—	—
STRS	67	Store Status in N	—	—	Trigger Proh'n states
SETS	36	Reset Status from N*	—	—	—
TAPE	04	Tape Input to N onwards	—	—	Prog.
MODY	34	Modify next instruction with (N)*	—	—	—
NULL	00	Do Nothing	—	—	—
AUGM	33	Add 1 to (N)	—	—	$N+1\cdot2^{-23}$
COUN	01	Count Next Instruction up to N*	—	—	—
MULT	54	Multiply (A) by (N)	(A)$\times$(N)		—
DVDE	55	Divide (AB) by (N)	(AB)$\div$N	$R\times2^{-24}$	—

The instructions marked * do not allow an interrupt to take effect until after the next instruction is obeyed.

Mathematical Signs and Symbols

Term	Symbol
brackets	$[\{(\ )\}]$
(Printers describe [ ] as brackets, { } as braces and ( ) as parentheses)	
plus	$+$
minus	$-$
plus or minus	$\pm$
difference between a and b	$\|a - b\|$
multiplied by	$\times$ or . (lower point)
divided by	$\div$ or /
equal to	$=$
approximately equal to	$\simeq$
of the order of	$\sim$
not equal to	$\neq$
identical with	$\equiv$
proportional to	$\propto$
greater than	$>$
less than	$<$
equal to or greater than	$\geqslant$
equal to or less than	$\leqslant$
much greater than	$\gg$
much less than	$\ll$
parallel to	$\parallel$
perpendicular to	$\perp$
limit of y	lim y
approaches a	$\rightarrow a$
infinity	∞
sum of	Σ
product of	Π
square root of	$\surd$
base of natural logarithms	$e \ldots \epsilon$
natural logarithm of x	In x, $\log_e x$
common logarithm of x	log x, $\log_{10} x$
antilogarithm	antilog
exponential function of x	exp x, e^x
factorial n	$n\,!$
ratio of circumference to diameter of circle	π
trigonometric circular functions of θ	sin θ: cos θ: tan θ: cosec θ: sec θ: cot θ
inverse trigonometric functions of y	$\sin^{-1} y$, arc sin y: etc.
hyperbolic functions of x	sinh x: cosh x: tanh x: cosech x: sech x: coth x
inverse hyperbolic functions of y	$\sinh^{-1} y$, arc sinh y: etc.

Term	*Symbol*
function of x	$f(x)$, $F(x)$, etc.
increment or finite difference operator ..	Δ, δ
differential coefficient of y with respect to x ..	$\frac{dy}{dx}$, dy/dx
differential coefficient, n^{th}	$\frac{d^n y}{dx^n}$, $d^n y/dx^n$
differential coefficient, partial	$\frac{\partial y}{\partial x}$, $\partial y/\partial x$
operator $\frac{d}{dx}$	D
integral of y with respect to x:	
indefinite	$\int y\,dx$
from $x = a$ to $x = b$	$\int_a^b y\,dx$
around a closed contour	$\oint y\,dx$
complex operator $\sqrt{(-1)}$	i, j
real part of ( )	$\mathscr{R}(\quad)$, Re( )
imaginary part of ( )	$\mathscr{I}(\quad)$, Im( )
modulus of complex number $z \equiv x + iy$ ..	$\lvert z \rvert \equiv \lvert x + iy \rvert$
argument of complex number z	arg z
vector of magnitude A	$\mathbf{A}$
scalar product of $\mathbf{A}$ and $\mathbf{B}$	$\mathbf{A.B}$
vector product of $\mathbf{A}$ and $\mathbf{B}$	$\mathbf{A} \times \mathbf{B}$ . . . $\mathbf{A} \wedge \mathbf{B}$
unit vectors of a rectangular co-ordinate system	$\mathbf{i}$, $\mathbf{j}$, $\mathbf{k}$
nabla or del $\left(\mathbf{i}\frac{\partial}{\partial x} + \mathbf{j}\frac{\partial}{\partial y}\mathbf{k} + \frac{\partial}{\partial z}\right)$	∇
Laplacian operator $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right)$ ..	∇^2
Bessel functions	J, Y, etc.
elliptic functions of u	sn u, cn u, dn u
gamma function of n	$\Gamma(n)$
error function of x	erf x
Heaviside unit function	$\mathbf{1}$
ith value of a variate x	x_i
average of several values of x	$\bar{x}$
standard deviation of a distributed variate ..	σ
number in a sample	n
correlation coefficient	ρ
range	w
basic quantities in dimensional equations ..	L, M, T, etc.

Algebraic and Trigonometric Formulæ

$\sin^2 A+\cos^2 A = \sin A \operatorname{cosec} A = 1$ $\qquad 1+\tan^2 A = \sec^2 A.$

$\sin A = \dfrac{\cos A}{\cot A} = \dfrac{1}{\operatorname{cose} A} = \sqrt{1-\cos^2 A}.$ $\qquad 1+\cot^2 A = \operatorname{cosec}^2 A.$

$\cos A = \dfrac{\sin A}{\tan A} = \dfrac{1}{\sec A} = \sqrt{1-\sin^2 A}.$ $\qquad 1-\sin A = \operatorname{coversin} A.$

$\text{tangent } A = \dfrac{\sin A}{\cos A} = \dfrac{1}{\cot A}$; $\tan \theta/2 = t$; $\sin\theta = \dfrac{2t}{1+t^2}$; $\cos\theta = \dfrac{1-t^2}{1+t^2}$

$\text{cotangent } A = \dfrac{1}{\tan A}$, $\text{secant } A = \dfrac{1}{\cos A}$, $\text{cosecant } A = \dfrac{1}{\sin A}$

$\sin(A\pm B) = \sin A \cos B \pm \cos A \sin B$; $\tan(A\pm B) = \dfrac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$

$\cos(A\pm B) = \cos A \cos B \mp \sin A \sin B.$ $\sinh u = (e^u - e^{-u}) \div 2$

$\cosh u = \dfrac{e^u+e^{-u}}{2}$; $\tanh u = \dfrac{e^u-e^{-u}}{e^u+e^{-u}}.$ $\cot(A\pm B) = \dfrac{\cot A \cot B \mp 1}{\cot B \pm \cot A}$

$\cosh^2 u - \sinh^2 u = 1$; $\sin A + \sin B = 2 \sin \tfrac{1}{2}(A+B) \cos \tfrac{1}{2}(A-B).$

$\sin^2 A - \sin^2 B = \sin(A+B)\sin(A-B)$; $\tan A \pm \tan B = \dfrac{\sin(A\pm B)}{\cos A \cos B}$

$\sin A - \sin B = 2 \cos \tfrac{1}{2}(A+B) \sin \tfrac{1}{2}(A-B).$ $\qquad e^{i\theta} = \cos\theta + i \sin\theta$

$\cos A + \cos B = 2 \cos \tfrac{1}{2}(A+B) \cos \tfrac{1}{2}(A-B).$ $\qquad e^{-i\theta} = \cos\theta - i \sin\theta$

$\cos B - \cos A = 2 \sin \tfrac{1}{2}(A+B) \sin \tfrac{1}{2}(A-B).$

$\cos\theta = \dfrac{e^{i\theta}+e^{-i\theta}}{2}$, $\sin\theta = \dfrac{e^{i\theta}-e^{-\theta}}{2i}$, $i = \sqrt{-1}$, $e^{in\theta} = \cos n\theta + i \sin n\theta$

$(\cos\theta + i \sin\theta)^n = \cos n\theta + i \sin n\theta$; $\cot A \pm \cot B = \dfrac{\sin(B\pm A)}{\sin A \sin B}$

$\sin 2A = 2 \sin A \cos A$; $\cos 2A = \cos^2 A - \sin^2 A.$

$\cos^2 A - \sin^2 B = \cos(A+B)\cos(A-B)$; $\qquad \tan 2A = \dfrac{2\tan A}{1-\tan^2 A}$

$\sin \tfrac{1}{2} A = \sqrt{\dfrac{1-\cos A}{2}}$, $\cos \tfrac{1}{2} A = \sqrt{\dfrac{1+\cos A}{2}}$, $\tan \tfrac{1}{2} A = \dfrac{\sin A}{1+\cos A}$

$\sin^2 A = \dfrac{1-\cos 2A}{2}$; $\qquad \cos^2 A = \dfrac{1+\cos 2A}{2}$; $\qquad \tan^2 A = \dfrac{1-\cos 2A}{1+\cos 2A}$

$\dfrac{\sin A \pm \sin B}{\cos A + \cos B} = \tan \tfrac{1}{2}(A\pm B).$ $\qquad \dfrac{\sin A \pm \sin B}{\cos B - \cos A} = \cot \tfrac{1}{2}(A \mp B).$

Angle	0	30°	45°	60°	90°	180°	270°	360°
Radians	0	$\pi/6$	$\pi/4$	$\pi/3$	$\pi/2$	π	$3\pi/2$	2π
Sine	0	$\tfrac{1}{2}$	$\tfrac{1}{2}\sqrt{2}$	$\tfrac{1}{2}\sqrt{3}$	1	0	-1	0
Cosine	1	$\tfrac{1}{2}\sqrt{3}$	$\tfrac{1}{2}\sqrt{2}$	$\tfrac{1}{2}$	0	-1	0	1
Tangent	0	$\tfrac{1}{3}\sqrt{3}$	1	$\sqrt{3}$	∞	0	∞	0

Approximations for Small Angles

$\sin\theta \doteq (\theta - \theta^3/6\ldots.)$; $\tan\theta \doteq (\theta + \theta^3/3\ldots.)$; $\cos\theta \doteq (1-\theta^2/2\ldots.)$ θ in radians; versine $\theta = 1-\cos\theta$; $\sin 14\tfrac{1}{2}° = \tfrac{1}{4}$; $\sin 20° = \tfrac{11}{32}$

Quadratic Equation

If $ax^2+bx+c = 0$, then $x = \dfrac{-b \pm \sqrt{b^2-4ac}}{2a}$

To find the sum of any number of terms in an arithmetical progression

$T_n = a+(n-1)d$; $S = n(a+l)/2 = n[2a+(n-1)d]/2$.
where a = first term; l = last term; n = number of terms; T_n = nth term; S = sum; d = common difference

To find the sum of any number of terms in a geometrical progression

Let r = common ratio, then $T_n = ar^{n-1}$; $S = \dfrac{a(r^n-1)}{r-1} = \dfrac{a(1-r^n)}{1-r}$

Combinations and Permutations

The number of combinations of n things r at a time is ${}_nC_r$.

$${}_nC_r = \frac{\underline{|n}}{\underline{|r}\,\underline{|n-r}} = {}_nC_{n-r}$$

The number of permutations of n things r at a time is ${}_nP_r$.

$${}_nP_n = n(n-1)\,(n-2) \text{———} 3\,.\,2\,.\,1 = \underline{|n}.$$
$${}_nP_r = n(n-1)\,(n-2) \text{———} (n-r+1).$$

Binomial Theorem

$$(1 \pm x)^n = 1 \pm nx + \frac{n(n-1)}{1\,.\,2}x^2 \pm \frac{n(n-1)\,(n-2)}{1\,.\,2\,.\,3}x^3 + \ldots\ldots$$

Maclaurin's Theorem

$$f(x) = f(o) + xf'(o) + \frac{x^2}{1\,.\,2}f''(o) + \ldots\ldots$$

Properties of "e"

$$e = 1 + 1 + \frac{1}{\underline{|2}} + \frac{1}{\underline{|3}} \ldots = 2{\cdot}71828;\quad e^x = 1 + x + \frac{x^2}{\underline{|2}} + \frac{x}{\underline{|3}} + \ldots$$

$\log_{10} e = 0{\cdot}43429$, $\log_e 10 = 2{\cdot}30259$, $e^{i\theta} = \cos\theta + i\sin\theta$, $(i^2 = -1)$
$e^u = \cosh u + \sinh u$.

Derivatives and Integrals.

y	$\dfrac{dy}{dx}$	$\int y\,dx$
x^n	nx^{n-1}	$x^{n+1}/n+1$
$1/x = x^{-1}$		$\log_e x$
$\sin \omega x$	$\omega \cos \omega x$	$-\cos \omega x/\omega$
$\cos \omega x$	$-\omega \sin \omega x$	$\sin \omega x/\omega$
$\tan \omega x$	$\omega \sec^2 \omega x$	$-\log \cos \omega x/\omega$
$\tan x$	$\sec^2 x$	$-\log \cos x$ or $\log \sec x$
$\cot x$	$-\mathrm{cosec}^2\, x$	$\log \sin x$
$\sec x$	$\tan x \sec x = \sin x/\cos^2 x$	$\log_e (\sec x + \tan x)$
$\mathrm{cosec}\, x$	$-\cot x\,\mathrm{cosec}\, x = -\dfrac{\cos x}{\sin^2 x}$	$\log_e (\mathrm{cosec}\, x - \cot x)$
$\sin^{-1}\left(\dfrac{x}{a}\right)$	$\dfrac{1}{\sqrt{a^2-x^2}}$	$x \sin^{-1}\dfrac{x}{a} + \sqrt{a^2-x^2}$
$\cos^{-1}\left(\dfrac{x}{a}\right)$	$-\dfrac{1}{\sqrt{a^2-x^2}}$	$x \cos^{-1}\dfrac{x}{a} - \sqrt{a^2-x^2}$
$\tan^{-1}\left(\dfrac{x}{a}\right)$	$\dfrac{a}{a^2+x^2}$	$x \tan^{-1}\dfrac{x}{a} - \dfrac{1}{a}\log_e \sqrt{a^2+x^2}$
e^x	e^x	e^x
e^{ax}	ae^{ax}	e^{ax}/a
$\log_e x$	$1/x$	$x(\log_e x - 1)$
$\log_a x$	$\dfrac{1}{x}\log_a e$	$x \log_a \dfrac{x}{e}$

$$\int \frac{dx}{x^2+a^2} = \frac{1}{a} \tan^{-1}\frac{x}{a}, \qquad \int \frac{xdx}{ax^2+b} = \frac{1}{2a} \log_e (ax^2+b)$$

$$\int \sqrt{x^2 \pm a^2}\,dx = \tfrac{1}{2}[x\sqrt{x^2 \pm a^2} \pm a^2 \log_e (x + \sqrt{x^2 \pm a^2})]$$

$$\int \sqrt{a^2-x^2}\,dx = \tfrac{1}{2}\left(x\sqrt{a^2-x^2}+a^2 \sin^{-1}\left(\frac{x}{a}\right)\right)$$

$$\int \frac{dx}{\sqrt{x^2 \pm a^2}} = \log_e (x+\sqrt{x^2 \pm a^2}). \qquad \int \frac{dx}{\sqrt{a^2-x^2}} = \sin^{-1}\frac{x}{a}$$

$$\int x\sqrt{x^2 \pm a^2}\,dx = \tfrac{1}{3}\sqrt{(x^2 \pm a^2)^3}. \qquad \int x\sqrt{a^2-x^2}\,dx = -\tfrac{1}{3}\sqrt{(a^2-x^2)^3}$$

$$\int \frac{xdx}{\sqrt{a^2-x^2}} = -\sqrt{a^2-x^2}. \qquad \int \frac{dx}{\sqrt{2ax-x^2}} = \cos^{-1}\frac{a-x}{a}$$

$$\int \sin^2 x dx = \tfrac{1}{2}(x-\sin x \cos x) = \tfrac{1}{2}x - \tfrac{1}{4}\sin 2x. \qquad \int \cos^2 x dx = \tfrac{1}{2}(x+\sin x \cos x) = \tfrac{1}{2}x+\tfrac{1}{4}\sin 2x.$$

If $y = f(u)$, $u = \varphi(x)$ then $\frac{dy}{dx} = \frac{dy}{du}\frac{du}{dx}$. $\qquad \oint$ integral round a curve.

If y is a product, uv, then $\frac{dy}{dx} = v\frac{du}{dx} + u\frac{dv}{dx}$. $\qquad \oint a \cos\theta\, ds = 0$

If y is a quotient, $\frac{u}{v}$, then $\frac{dy}{dx} = \left(v\frac{du}{dx} - u\frac{dv}{dx}\right) \Big/ v^2$.

$$\int u\frac{dv}{dx}\,dx = [uv] - \int v\frac{du}{dx}\,dx.$$

TRIGONOMETRIC SOLUTION OF TRIANGLES.

Right-Angled Triangles. (Right angle at C).

$\sin A = \frac{a}{c}$. $\cos B = \frac{a}{c}$. $b = \sqrt{c^2-a^2} = \sqrt{(c+a)(c-a)}$

Area $= \frac{a}{2}\sqrt{c^2-a^2} = \frac{ab}{2} = \frac{a^2 \cot A}{2} = \frac{b^2 \tan A}{2}$. $\tan A = \frac{a}{b}$.

$B = 90° - A$, $b = a \cot A$, $c = \frac{a}{\sin A}$ $c = \sqrt{a^2+b^2}$. covers $A = \frac{b-a}{b}$

$a = c \sin A$, $b = c \cos A$, Area $= \frac{c^2 \sin A \cos A}{2}$, vers $A = \frac{c-b}{c}$

Oblique-Angled Triangles.

$\sin \frac{1}{2} A = \sqrt{\frac{(s-b\,(s-c)}{bc}}$, $\cos \frac{1}{2} A = \sqrt{\frac{s(s-a)}{bc}}$, $s = \frac{a+b+c}{2}$

$\tan \frac{1}{2} A = \sqrt{\frac{(s-b\,(s-c)}{s\,(s-a)}}$, similar values for Angles B and C

Area $= \sqrt{s(s-a)(s-b)(s-c)} = \frac{1}{2} ab \sin C = \frac{a^2 \sin B \sin C}{2 \sin A}$

$b = \frac{a \sin B}{\sin A}$, $c = \frac{a \sin C}{\sin A} = \frac{a \sin (A+B)}{\sin A} = \sqrt{a^2+b^2-2ab \cos C}$

$\tan A = \frac{a \sin C}{b-a \cos C}$ $\qquad \tan \frac{1}{2}(A-B) = \frac{a-b}{a+b} \cot \frac{1}{2} C$

$a^2 = b^2+c^2-2bc \cos A$, $b^2 = a^2+c^2-2ac \cos B$, $c^2 = a^2+b^2-2ab \cos C$

Time Differences

Time differences for various cities, fast or slow, compared with Greenwich Mean Time.

Hours Fast

Amsterdam	1	Karachi	5
Ankara	2	Kuala Lumpur	7½
Athens	2	Lagos	1
Baghdad	3	Madrid	1
Bangkok	7	Manila	8
Beirut	2	Moscow	3
Belgrade	1	Oslo	1
Berne	1	Paris	1
Bonn	1	Peking	8
Brussels	1	Prague	1
Bucharest	2	Pretoria	2
Budapest	1	Rangoon	6½
Cairo	2	Rome	1
Canberra	10	Salisbury (S.R.)	2
Colombo	5½	Seoul	8½
Copenhagen	1	Stockholm	1
Damascus	2	Tehran	3½
Delhi	5½	Tokyo	9
Djarkata	7½	Vienna	1
Helsinki	2	Warsaw	1
Jerusalem	2	Wellington (N.Z.)	12

Hours Slow

Bogota	5	Montevideo	3
Buenos Aires	3	Ottawa	5
Caracas	4½	Port au Prince	5
Guatemala	6	Quito	5
Havana	5	Rio de Janeiro	3
Lima	5	Santiago	4
Mexico City	6	Washington (D.C.)	5

GREENWICH MEAN TIME

Accra   Lisbon

Time-Frequency Table

The Table provides a quick evaluation of frequency when used with oscilloscopes having a time-calibrated X axis. Entries in the 'Time' column apply to the length of one cycle in the observed waveform. Corresponding time and frequency units are:
milliseconds – Hz; microseconds – kHz; nanoseconds – MHz.

Time	Frequency	Time	Frequency	Time	Frequency	Time	Frequency	Time	Frequency	Time	Frequency
1.0	1,000	5.5	182	10	100	55	18.2	100	10.0	550	1.82
1.25	800	5.75	174	12.5	80.0	57.5	17.4	125	8.00	575	1.74
1.5	667	6.0	167	15	66.7	60	16.7	150	6.67	600	1.67
1.75	571	6.25	160	17.5	57.1	62.5	16.0	175	5.71	625	1.60
2.0	500	6.5	154	20	50.0	65	15.4	200	5.00	650	1.54
2.25	444	6.75	148	22.5	44.4	67.5	14.8	225	4.44	675	1.48
2.5	400	7.0	143	25	40.0	70	14.3	250	4.00	700	1.43
2.75	364	7.25	138	27.5	36.4	72.5	13.8	275	3.64	725	1.38
3.0	333	7.5	133	30	33.3	75	13.3	300	3.33	750	1.33
3.25	308	7.75	129	32.5	30.8	77.5	12.9	325	3.08	775	1.29
3.5	286	8.0	125	35	28.6	80	12.5	350	2.86	800	1.25
3.75	267	8.25	121	37.5	26.7	82.5	12.1	375	2.67	825	1.21
4.0	250	8.5	118	40	25.0	85	11.8	400	2.50	850	1.18
4.25	235	8.75	114	42.5	23.5	87.5	11.4	425	2.35	875	1.14
4.5	222	9.0	111	45	22.2	90	11.1	450	2.22	900	1.11
4.75	211	9.25	108	47.5	21.1	92.5	10.8	475	2.11	925	1.08
5.0	200	9.5	105	50	20.0	95	10.5	500	2.00	950	1.05
5.25	190	9.75	103	52.5	19.0	97.5	10.3	525	1.90	975	1.03

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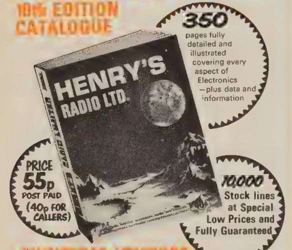

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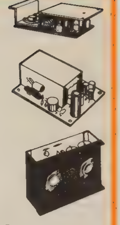

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104	4 TR 9 Volt 1 Watt	£2.12
304	4 TR 9 Volt 3 Watt	£2.47
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608	6 TR 24 Volt 10 Watt	£4.12
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PS.20 (One or Two) for PA7	£3.47
MU24/40 (One or Two) for MPA12/3 or MPA12/15	£4.50
PZ5 for Z30 £3.97	or PZ6 for Z30 £6.97
PZ8 for Z50 £5.97	Transformer £2.25
P11 for 608 £2.87	P15 for 410 £2.62
MU442 for one or two PA25, or one only for PA50	£6.50

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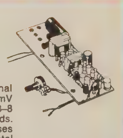

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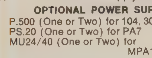

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FET.154 plus 2xPA25 plus MU442 **£36** Post 50p
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9 volt operated 2-speed tape deck fitted Record/Replay ½ track and Erase/Bias Osc. Head. Complete with Oscillator/Record head circuit Unit size 9" x 6⅝" x 1⅝" and 2¼" below motor board. Takes up to 4" spools. Supplied brand new 300ft. 3¼" Tape & Spool **40p**

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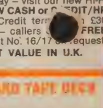

Excellent printed circuit design with full power output. Fully tuneable on both MW/LW bands. 7 Mullard transistors. Fitted 5in. speaker. Room-filling power. Easy to build with terrific results. Two-colour leathercloth cabinet with silvered front. All local and continental stations. Complete detailed instructions. **Ask for Leaflet No. 1.** Total cost **£6.98** p.p. 35p
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Also **NEW FM TUNER** Price **£21.00**

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Mains unit for Tuner and Decoder PS1200 **£2.62**

Foreign Language Broadcasts

The Table lists B.B.C. transmissions in the languages shown. Two-figure numbers indicate Metre Bands and three-figure numbers indicate Metres. Where applicable, days are quoted in brackets. Time is in GMT. The list will be completed in Data Sheets 56 and 57

ARABIC
0345–0545 16, 19, 25, 31, 41, 49 and 198, 417, 428, 470m.
1300–2100 11, 13, 16, 19, 25, 31, 41 or 49 and 198, 417, 428 or 470m.

BENGALI
0130–0145 19, 25, 31, 41
0930–1000 13, 16 (W)
1415–1430 13, 16, 19, 25
1615–1645 25 (W)

BULGARIAN
0445–0500 16, 19, 25, 31, 41
1130–1145 13, 16, 19, 25
1400–1415 13, 16, 19
1645–1730 16, 19, 25, 31
1915–1930 41, 49 (Tu, Th, Sat)
2130–2200 19, 25, 31, 41, 49

BURMESE
0015–0030 19, 25, 31
1345–1415 13, 16, 25, 31
2330–2345 31, 49

CHINESE
Standard Chinese
1000–1030 13, 16, 19, 25, 31, 41
1200–1245 13, 16, 19, 25, 31, 41
2230–2245 19, 25, 31, 41, 49, 75

Cantonese
1245–1300 13, 16, 19, 25, 31, 41
2215–2230 19, 25, 31, 41, 49, 75

CZECH/SLOVAK
0515–0530 25, 31, 41, 49 and 232, 464m.
0615–0630 25, 31, 41, 49
1115–1130 16, 19, 25, 31 *(Slovak)*
1345–1400 19, 25, 31 (Su, Tu, Th, Sa)
1400–1430 19, 25, 31
1430–1445 19, 25, 31 (Su)
1600–1615 19, 25, 31 *(Slovak)*
1845–1900 19, 25, 31, 41, 49
1945–2015 19, 25, 31, 41, 49 and 232m.
2045–2115 19, 25, 31, 41, 49 and 232m. until 2100 *(Slovak)*
2145–2200 25, 31, 41, 49

FINNISH
1530–1600 19, 25, 31 (Su)
1545–1600 19, 25, 31 (M, W, Th, Sa)
1600–1645 19, 25
1930–1945 31, 41

FRENCH
Africa
0430–0445 19, 25, 31, 41
0515–0545 19, 25, 31, 41

(Africa ctd.)
0630–0700 19, 25, 31, 41
1200–1330 13, 16
1830–1930 13, 16, 19, 31
2115–2130 25, 31
2130–2145 16, 25, 31

Europe
0530–0545 232m.
0630–0645 31, 41, 49 and 232m., also 464m. (Sa, Su)
0715–0730 31, 41, 49 and 232m.
1115–1230 19, 25, 31, 49 and 371m.
1800–1900 31, 41, 49 and 232m.
2130–2145 41, 49, 75 and 232m.

GERMAN
0415–0500 31, 41, 49, 75 and 232, 464m.
0515–0600 25, 31, 41, 49 or 75
1145–1215 19, 25, 31, 41
1615–1630 371m. and 90.2MHz
1630–1700 25, 31, 49 and 232m.
1900–2100 31, 49, 75 and 232m. until 1945
2245–2300 41, 49, 75 and 232m.

(Also broadcast on 371m. and 90.2MHz for listeners in Greater Berlin)

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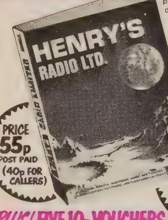

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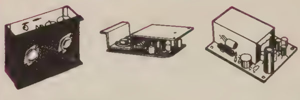

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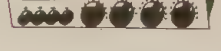
4–300 4TR 9V 300mW	**£1.75**	PA7 6TR 16V 7W	**£3.62**
104 4TR 9V 1W	**£2.12**	608 6TR 24V 10W	**£4.12**
304 4TR 9V 3W	**£2.47**	410 4TR 28V 10W	**£4.97**
555 6TR 12V 3W	**£2.75**	MPA12/3 6TR 18V 12W	**£4.50**
		MPA12/15 6TR 36V 12W	**£5.25**

OPTIONAL POWER SUPPLIES Post, etc., 20p

P500 (1 or 2) for 104, 304	**£2.62**
PS20 (1 or 2) for PA7	**£3.47**
MU24/40 (1 or 2) for MPA12/3 or MPA12/15	**£4.50**
P11 for 608 **£2.87** P15 for 410	**£2.62**

SINCLAIR PROJECT 60 PACKAGE DEALS - SAVE POUNDS!



2xZ30 amplifier, stereo 60 pre-amp, PZ5 power supply, **£16.75.** Carr. 40p. Or with PZ6 power supply **£18.25.** Carr. 40p. 2xZ50 amplifier, stereo 60 pre-amp, PZ8 power supply, **£20.25.** Carr. 40p. Transformer for PZ8 **£2.45** extra. Any of the above with Active Filter unit add **£4.75** or with pair Q16 speakers add **£16.** Also new FM Tuner **£21.** 2000 Amplifier **£24.50,** p.p. 50p. 3000 Amplifier **£31.50,** p.p. 50p. Also IC12 **£2.50.**

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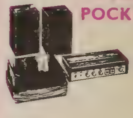

TELETON '206', Garrard SP25 Mk III, Goldring G800 Series Cart, Plinth/Cover, 10 watt 3 way bookshelf Speaker Systems, All leads, etc. (Rec. Price £81)

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Plus free pair Stereo headphones

TELETON F2000 Med. Wave, Stereo FM Tuner Amplifier, Garrard 2025 TC, 9TAHC Diam, Plinth/Cover, 10 watt Speaker Systems as above, all leads, etc (Rec Price £91)

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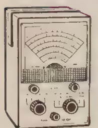

AF105 50k/V multimeter (illus.). Price **£8.50,** p.p. 20p. Leather case £1.42
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TE65 Valve voltmeter (illus.). Price **£17.50,** p.p. 40p
SE250B Pocket pencil signal injector. Price **£1.75,** p.p. 15p

SE500 Pocket pencil signal tracer. Price **£1.50,** p.p. 15p
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TE22D Matching audio generator. Price **£17,** p.p. 40p
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E.M.I. Size 13½" by 8½"

TYPE 150 6 watt, 3, 8 or 15 ohms **£2.12.** Post 22p
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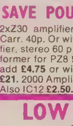

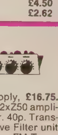

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PA25 25 watts into 8 ohms **£7.50**
PA50 50 watts into 4 ohms **£9.50**
MU442 Power Supply for 1 or 2 PA25's or 1 only PA50 **£6.00.** Post 20p

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TOTAL **£6.97** p.p. 20p

Cabinet **£1.00.** Decoder Kit **£5.97.** Tuning Meter **£1.75.** Mains unit (optional) Model PS900 Mains unit for Tuner and Decoder PS1200 **£2.62**

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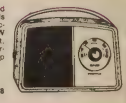

Printed circuit all-transistor design using Mullard RF/IF Module. Medium and Long Wave bands plus Medium Wave Bandspread for extra selectivity. Also slow-motion geared tuning, 600mW push-pull output, fibre glass PVC covered cabinet, car aerial socket. Attractive appearance and performance TOTAL COST TO BUILD **£7.98** p.p. 32p (Battery 22p)

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FOREIGN LANGUAGE BROADCASTS

The Table lists B.B.C. transmissions in the languages shown. Two-figure numbers indicate Metre Bands and three-figure numbers indicate Metres. Times are in G.M.T. and, where applicable, days are quoted in brackets. The list started in Data Sheet 55 and will be completed in Data Sheet 57

GREEK
0545–0600 16, 19, 25, 31, 41
1300–1315 16, 19, 25
1545–1600 13, 16, 19 (Su, M, W, F)
1900–1930 19, 25, 31
2230–2300 25, 31, 41

HAUSA
0545–0600 19, 25, 31, 41
1345–1415 13, 16
1930–1945 13, 16, 19, 31
1945–2000 19, 31

HINDI
0050–0110 31, 41, 49 and 213, 428m.
0140–0200 31, 41, 49 and 213m.
1430–1515 13, 16, 19, 25 and 213m.
1600–1615 13, 16, 25 and 213m.

HUNGARIAN
0530–0545 25, 31, 41, 49
0630–0645 25, 31, 41, 49
1000–1030 19, 25 (Su)
1215–1230 19, 25, 31
1345–1400 19, 25, 31 (M, W, F)
1515–1530 19, 25, 31
1900–1945 19, 25, 31, 41, 49
2200–2245 25, 31, 41, 49 and 232m. from 2215

INDONESIAN
1030–1100 13, 16, 25, 31, 41
2315–2330 25, 31, 41, 49, 75

ITALIAN
0915–0930 13, 16, 19 (Su)
1430–1445 16, 19, 25 (ex Su)
2100–2130 31, 41, 49, 75 and 232m.

JAPANESE
1100–1130 13, 16, 19, 25
2200–2215 19, 25, 31, 41, 49

MALAY
1300–1315 13, 16

MALTESE
1650–1655 25, 31

MAURITIUS (English and French)
1000–1015 13 (alt M)

NEPALI
0930–1000 13, 16 (Sa)
1615–1645 25 (Sa)

PERSIAN
0200–0230 31, 41, 49
0315–0345 31, 41, 49 and 213, 417, 428m.
1615–1700 13, 16, 31, 41 and 213, 417m.

POLISH
0400–0415 31, 41, 49 and 232, 464m.
0500–0515 25, 31, 41, 49, 75 and 232, 464m.
0600–0615 25, 31, 41, 49
1315–1330 19, 25, 31
1330–1345 19, 25, 31 (Su, W, Sa)
1500–1515 19, 25, 31
1545–1600 19, 25, 31 (M, Th)
1800–1845 19, 25, 31, 41
2015–2045 19, 25, 31, 41, 49 and 232m.
2115–2145 25, 31, 41, 49

PORTUGUESE
Europe
1230–1245 19, 25
2200–2230 41, 49
Brazil
2200–0015 16, 19, 25, 31

Inch-Millimetre Table I

Metrication in electronics is advancing rapidly, particularly in the dimensional field. The Table lists millimetre equivalents to 'round number' inch values from 0.005 to 0.5 in. Millimetres are given to four significant figures.

in.	*mm.*	*in.*	*mm.*	*in.*	*mm.*	*in.*	*mm.*
0.005	0.1270	0.08	2.032	0.21	5.334	0.36	9.144
0.01	0.2540	0.085	2.159	0.22	5.588	0.37	9.398
0.015	0.3810	0.09	2.286	0.23	5.842	0.38	9.652
0.02	0.5080	0.095	2.413	0.24	6.096	0.39	9.906
0.025	0.6350	0.1	2.540	0.25	6.350	0.40	10.16
0.03	0.7620	0.11	2.794	0.26	6.604	0.41	10.41
0.035	0.8890	0.12	3.048	0.27	6.858	0.42	10.67
0.04	1.016	0.13	3.302	0.28	7.112	0.43	10.92
0.045	1.143	0.14	3.556	0.29	7.366	0.44	11.18
0.05	1.270	0.15	3.810	0.30	7.620	0.45	11.43
0.055	1.397	0.16	4.064	0.31	7.874	0.46	11.68
0.06	1.524	0.17	4.318	0.32	8.128	0.47	11.94
0.065	1.651	0.18	4.572	0.33	8.382	0.48	12.19
0.07	1.778	0.19	4.826	0.34	8.636	0.49	12.45
0.075	1.905	0.20	5.080	0.35	8.890	0.50	12.70

Inch-Millimetre Table II

This Table completes the inch-millimetre equivalents given in Data Sheet 58, and lists millimetre equivalents to 'round number' inch values from 0.51 to 10 in. Millimetres are given to four significant figures.

in.	*mm.*	*in.*	*mm.*	*in.*	*mm.*	*in.*	*mm.*
0.51	12.95	0.66	16.76	0.81	20.57	0.96	24.38
0.52	13.21	0.67	17.02	0.82	20.83	0.97	24.64
0.53	13.46	0.68	17.27	0.83	21.08	0.98	24.89
0.54	13.72	0.69	17.53	0.84	21.34	0.99	25.15
0.55	13.97	0.70	17.78	0.85	21.59	1.00	25.40
0.56	14.22	0.71	18.03	0.86	21.84	2.00	50.80
0.57	14.48	0.72	18.29	0.87	22.10	3.00	76.20
0.58	14.73	0.73	18.54	0.88	22.35	4.00	101.6
0.59	14.99	0.74	18.80	0.89	22.61	5.00	127.0
0.60	15.24	0.75	19.05	0.90	22.86	6.00	152.4
0.61	15.49	0.76	19.30	0.91	23.11	7.00	177.8
0.62	15.75	0.77	19.56	0.92	23.37	8.00	203.2
0.63	16.00	0.78	19.81	0.93	23.62	9.00	228.6
0.64	16.26	0.79	20.07	0.94	23.88	10.00	254.0
0.65	16.51	0.80	20.32	0.95	24.13		

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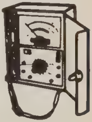

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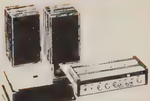

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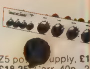

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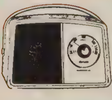

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Millimetre-Inch Table I

Continuing the metrication series, the Table lists inch equivalents to 'round number' millimetre values from 0.5 to 40mm. Inches are given to four significant figures.

mm.	*in.*	*mm.*	*in.*	*mm.*	*in.*	*mm.*	*in.*
0.5	0.01969	8.0	0.3150	15.5	0.6102	26.0	1.024
1.0	0.03937	8.5	0.3347	16.0	0.6299	27.0	1.063
1.5	0.05906	9.0	0.3543	16.5	0.6496	28.0	1.102
2.0	0.07874	9.5	0.3740	17.0	0.6693	29.0	1.142
2.5	0.09843	10.0	0.3937	17.5	0.6890	30.0	1.181
3.0	0.1181	10.5	0.4134	18.0	0.7087	31.0	1.220
3.5	0.1378	11.0	0.4331	18.5	0.7284	32.0	1.260
4.0	0.1575	11.5	0.4528	19.0	0.7480	33.0	1.299
4.5	0.1772	12.0	0.4724	19.5	0.7677	34.0	1.339
5.0	0.1969	12.5	0.4921	20.0	0.7874	35.0	1.378
5.5	0.2165	13.0	0.5118	21.0	0.8268	36.0	1.417
6.0	0.2362	13.5	0.5315	22.0	0.8661	37.0	1.457
6.5	0.2559	14.0	0.5512	23.0	0.9055	38.0	1.496
7.0	0.2756	14.5	0.5709	24.0	0.9449	39.0	1.535
7.5	0.2953	15.0	0.5906	25.0	0.9843	40.0	1.575

Millimetre-Inch Table II

Concluding the metrication series, the Table lists inch equivalents to 'round number' millimetre values from 41 to 100mm. Inches are given to four significant figures.

mm.	in.	mm.	in.	mm.	in.	mm.	in.
41	1.614	56	2.205	71	2.795	86	3.386
42	1.654	57	2.244	72	2.835	87	3.425
43	1.693	58	2.283	73	2.874	88	3.465
44	1.732	59	2.323	74	2.913	89	3.504
45	1.772	60	2.362	75	2.953	90	3.543
46	1.811	61	2.402	76	2.992	91	3.583
47	1.850	62	2.441	77	3.031	92	3.622
48	1.890	63	2.480	78	3.071	93	3.661
49	1.929	64	2.520	79	3.110	94	3.701
50	1.969	65	2.559	80	3.150	95	3.740
51	2.008	66	2.598	81	3.189	96	3.780
52	2.047	67	2.638	82	3.228	97	3.819
53	2.087	68	2.677	83	3.268	98	3.859
54	2.126	69	2.717	84	3.307	99	3.898
55	2.165	70	2.756	85	3.346	100	3.937

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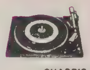

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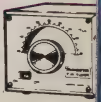

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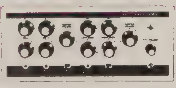

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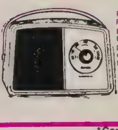

Printed circuit all-transistor design usi RF/IF Module Medium and Long W plus Medium Wave Bandspread for e tivity. Also slow-motion geared tunin push-pull output, fibre glass PVC cover car aerial socket. Attractive appearanc formance. TOTAL COST TO BUILD £7.
(Battery 22p)
All parts sold separately – Leaflet
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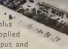
D.S.C. WIRE COIL LENGTHS

The Table lists lengths, in inches, of close-wound coils using d.s.c. (double silk covered) enamelled copper wire. Thus, a 70 turn coil of 28 s.w.g. wire has a length of 1.3in. Similar coil lengths will be given with d.r.c. (double rayon covered) enamelled wire.

Wire Gauge (s w g)	10 Turns	20 Turns	30 Turns	40 Turns	50 Turns	60 Turns	70 Turns	80 Turns	90 Turns	100 Turns
16	0.71	1.4	2.1	2.8	3.6	4.3	5.0	5.7	6.4	7.1
18	0.53	1.1	1.6	2.1	2.7	3.2	3.7	4.2	4.8	5.3
20	0.41	0.82	1.2	1.6	2.1	2.5	2.9	3.3	3.7	4.1
22	0.33	0.66	0.99	1.3	1.7	2.0	2.3	2.6	3.0	3.3
24	0.27	0.54	0.80	1.1	1.3	1.6	1.9	2.1	2.4	2.7
26	0.22	0.44	0.66	0.88	1.1	1.3	1.6	1.8	2.0	2.2
28	0.19	0.37	0.56	0.74	0.93	1.1	1.3	1.5	1.7	1.9
30	0.16	0.32	0.48	0.63	0.79	0.95	1.1	1.3	1.4	1.6
32	0.14	0.28	0.43	0.57	0.71	0.85	1.0	1.1	1.3	1.4
34	0.12	0.25	0.37	0.49	0.62	0.74	0.86	0.99	1.1	1.2
36		0.22	0.32	0.43	0.54	0.65	0.76	0.86	0.97	1.1
38		0.18	0.27	0.36	0.45	0.54	0.64	0.73	0.82	0.91
40		0.16	0.24	0.31	0.39	0.47	0.55	0.63	0.71	0.79

build the Texan and Stereo FM Tuner
20 WATT IC STEREO AMPLIFIER



fibre PC Board. Gardners low field transformer, 6–IC's, 10–transistors plus
Designed by Texas instruments engineers for Henry's and P.W. 1972. Supplied
sis work, detailed construction handbook and all necessary parts. Full input and
es. Stabilised supply. Overall size 15½ × 2¾" × 6⅛" mains operated. Free teak sleeve with

31.00 (carriage 50p) (also built and tested £37·50)

HENELEC STEREO FM TUNER

Features capacity diode tuning, lead and tuning meter indicators, stabilised power supply—mains operated. High performance and sensitivity with unique station indication IC stereo decoder. Overall size in teak sleeve 8" × 2½" × 6⅜". Complete kit with teak sleeve.

£21.00 (GB post paid) (also built and tested £24·95)

HE LARGE BAND OF HAPPY CONSTRUCTORS!

STORISED MODULES
Power Suppliers - Amplifiers
RS (All single channel unless stated)

	£ p
volt 300 MW	1.75
volt 250 MW	2.70
volt 1 watt	3.10
volt 3 watt	3.95
2 volt 3 watt	4.10
2 volt 1½ + 1½ watt	5.95
2 volt 5 watt	5.10
4 volt 10 watt	4.95
8 volt 10 watt	4.95
5 volt 30 watt	9.95
0/35 volt 15 watt	5.45
5/50 volt 25 watt	6.95
4 volt 6 + 6	10.20

with controls

2 volt 2½ - 2½ watts 8 ohms	8.25
lains 5 watts 4–16 ohms	6.30
lains 7 - 7 watts 8 ohms	11.75
lains 15 + 15 watts 8 ohms	14.95
volt 1½+1½ watts 8 ohms	6.95
2 volt 3 + 3 watts 8 ohms	10.50

ULES

186 FM tuner (front end) with data O/P	4.85
185 10.7 MHZ IF unit with data	4.50
ability FM tuner (front end) O/P	4.20

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) 6 volt fm tuner	7.95
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5 volt FM tuner stereo recorder	7.45
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art/Tape/Mic Inputs 9 volt	2.85
ereo 3–30mV mag. cart. 9 volt	4.75
ereo 3mV tape head 9 volt	4.95
ereo 5–20mV Mag. cart. mains	5.95
ono 3–250 mV Tape Cart Flay 9 volt	1.95

SUPPLIES MAINS INPUT
cased)

300 MA with ad'rs	2.25
00 MA	3.20
½/9v. 400 MA stabilised	5.50
np 3.30	3.30
mp.	3.30
A 4.70	4.70
9A	7.80
4–1 amp	7.15
2V, 1 amp stabilised	12.75
½/9/12V ½ amp	4.20
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13 in x 8 in chassis speakers
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*150 TC 10 watts 8 ohms twin cone **£2.20**
*450 10 watts 4, 8, 15 ohm with twin tweeters and crossover **£3.85** each
EW 15 watt 8 ohm with tweeter **£5.25**
350 20 watt 8, 15 ohm with tweeter **£7.80** each

* Polished wood cabinet **£4.80** carr., etc. 35p each or 50p pair.

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625 line receiver UHF transistorised tuners UK operation. Brand new. (Post packing 25p each).
TYPE C variable tuning **£2.50**
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*HM350 in circuit transistor tester	19.50
*C3925Deluxe meter 1–300mHz	6.95
*TT145 Compact transistor tester	14.75
– G3/36 R/C osc 20Hz–200kHz	£19.75
– CD342 SWR Meter	£5.75
– SE350A De luxe signal tracer	£12.95
– SE400 Mini-lab all in one tester	£15.50
C-15 Scope 500.000kHz (carr. £1)	£43.00
– C4043 5 CH F/A meter 1–300MHz	£5.75
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Mains unit for above (carr 50p)	£3.75

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Marriot XRSP/36¼ Track Med.	£5.00
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Marriot Erase Heads for XRSP 17/18/36 (XES11)	75p
Marriot BXIZE 343 ¼ track erase	75p
R/RPI Record/Play ½ Track	45p
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Miniature Stereo Cassette Rec/Play	£2.25

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Special purchase 5 watt output 8–16 ohm load, 30 volt max. DC operation, complete with data. Price **£1.50** each or 2 for **£2.85**. Printed Circuit Panels **50p.**

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Sinclair Cambridge Kit	£13.50
Sinclair Cambridge (Builts)	£17.50
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Sinclair Scientific Kit	£18.50

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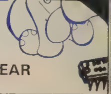

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SN7406N	0 42	SN74182N	1·26	BFY50
SN7407N	0 42	SN74184N	1·80	BFY51
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SN7411N	0 25	SN74192N	2·00	BSX20
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SN7413N	0 36	SN74194N	1·30	BY100
SN7414N	0 72	SN74195N	1·10	BY127
SN7416N	0 36	SN74196N	1·20	BYZ13
SN7417N	0 36	SN74197N	1·20	C1060
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SN7423N	0 37	CA3012	[illegible]	LM309K
SN7425N	0 37	CA3014	1 80	MAT121
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SN7427N	0·37	CA3019	1·12	MJE520
SN7428N	0 40	CA3020	1 50	MJE3055
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SN7432N	0 37	CA3028A	1 03	MPF105
SN7433N	0 37	CA3036	1·08	NKT404
SN7437N	0 37	CA3046	1 03	OA5
SN7438N	0 37	CA3048	2·76	OA81
SN7440N	0 22	CA3075	1 75	OA200
SN7441AN	·0·92	CA3081	1·80	OA202
SN7442N	0 79	CA3089E	2·94	OC28
SN7443N	1 27	CA30900	5·40	OC35
SN7444AN	1 27	**Signetics**		OC36
SN7445N	1 60	NE555	0·65	OC44
SN7446N	1 89	NE560B	4·50	OC45
SN7447AN	1 60	NE561B	4·50	OC71
SN7448N	1 27	NE562B	4·50	OC72
SN7450N	0 16	NE567B	2·65	OC77
SN7451N	0·16	**Motorola**		OC81
SN7453N	0·16	MC1303L	1·42	OC83
SN7454N	0·16	MC1304P	1·79	OC141
SN7460N	0·16	MC1310P	2·91	OC170
SN7470N	0·36	MC1458CF	0 77	OC200
SN7472N	0 38	MC1710CC	0 60	OC202
SN7473N	0·41	MFC4000P	0·45	OCP71
SN7474N	0·42	MFC4010P	0·55	ORP12
SN7475N	0·59	MFC6040P	1 00	ORP60
SN7476N	0 45	**Others**		P346A
SN7480N	0·60	TBA800	1·50	TIL209
SN7481N	1·10	SN76003N	1·50	TIP29A
SN7482N	0·87	SN72741P	0·60	TIP30A
SN7483N	1 10	SN72748P	0·61	TIP31A
SN7484N	1 00	702C	0·75	TIP41A
SN7485N	1·63	709C	0·39	TIP42A
SN7486N	0 47	723C	0·90	TIS43
SN7489N	3 87	728C	0·45	V405A
SN7490N	0 55	741C	0·60	ZTX108
SN7491AN	1 00	747C	1·00	ZTX300
SN7492N	0·70	748C	0·61	ZTX302
SN7493N	0·70	LM309K	2·00	ZTX500
SN7494N	0·80	TAA960	1·75	2N697
SN7495N	0·80	**Sinclair**		2N706
SN7496N	0·95	IC12.6W. Amp	2·20	2N930
SN7497N	3 87	AAZ13	0·12	2N987
SN74100N	1 89	AC107	0·51	2N1132
SN74104N	0 58	AC128	0 15	2N1304
SN74105N	0 53	AC187	0·21	2N1613
SN74107N	0·45	ACY17	0·40	2N1671
SN74110N	0·58	ACY39	0·78	2N2147
SN74111N	0 86	AD149	0·50	2N2160
SN74116N	1 89	AD161	0·44	2N2926
SN74118N	0·90	AD162	0 44	2N3053
SN74119N	1·68	AF117	[illegible]	2N3054
SN74120N	0·95	AF118	[illegible]	2N3055
SN74121N	0·50	AF139	[illegible]	2N3440
SN74122N	0·70	AF186	[illegible]	2N3442
SN74123N	1·00	AF239	0 44	2N3525
SN74125N	0 65	ASY27	0 33	2N3614
SN74132N	0 72	BA115	0 10	2N3702
SN74141N	0·90	BAX13	0 05	2N3714
SN74145N	1·26	BC107	0·14	2N3771
SN74150N	1·75	BC108	0·13	2N3773
SN74151N	1·00	BC109	0·14	2N3790
SN74153N	0·95	BC109C	0·16	2N3819
SN74154N	2 00	BC113	0·15	2N3886
SN74155N	1 00	BC147	0·10	2N3903
SN74156N	1 00	BC148	0·08	2N4002
SN74157N	0 95	BC149	0 10	2N4126
SN74160N	1·38	BC169C	0·15	2N4871
SN74161N	1·38	BC182	0·12	2N5457
SN74162N	1 38	BCY32	0·85	2S303
SN74163N	1 38	BCT39	1 50	40550
SN74164N	1 76	BCY55	2·64	40361
SN74165N	1 76	BCY70	0 18	40362
SN74166N	1 60	BCY71	0·22	40408
SN74167N	3·00	BCY72	0·12	40486
SN74170N	2·52	BD124	0·65	40636
SN74173N	1 66	BD131	0·42	40430

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WEIGHT CONVERSION TABLE 1

The Table lists metric equivalents in grams (gr.) and kilograms (kg.) for 'round number' avoirdupois weights from 0.1 oz. to 100 lb. The metric values are given to three significant figures.

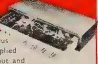
oz.	gr.	oz.	gr.	lb.	kg.	lb.	kg.
0.1	2.84	1	28.4	1	0.454	16	7.26
0.15	4.25	2	56.7	2	0.907	17	7.71
0.2	5.67	3	85.1	3	1.36	18	8.16
0.25	7.09	4	113	4	1.81	19	8.62
0.3	8.51	5	142	5	2.27	20	9.07
0.35	9.92	6	170	6	2.72	25	11.3
0.4	11.3	7	198	7	3.18	30	13.6
0.45	12.8	8	227	8	3.63	35	15.9
0.5	14.2	9	255	9	4.08	40	18.1
0.55	15.6	10	284	10	4.54	50	22.7
0.6	17.0	11	312	11	4.99	60	27.2
0.65	18.4	12	340	12	5.44	70	31.8
0.7	19.8	13	369	13	5.90	80	36.3
0.8	22.7	14	397	14	6.35	90	40.8
0.9	25.5	15	425	15	6.80	100	45.4

WEIGHT CONVERSION TABLE II

The Table lists avoirdupois equivalents in oz. and lb. for 'round number' metric weights from 1 gram (gm.) to 100 kilograms (kg.). The avoirdupois values are given to three significant figures.

gm.	oz.	gm.	oz.	kg.	lb.	kg.	lb.
1	0.0353	30	1.06	0.5	1.10	15	33.1
2	0.0705	40	1.41	0.6	1.32	20	44.1
3	0.106	50	1.76	0.7	1.54	25	55.1
4	0.141	60	2.12	0.8	1.76	30	66.2
5	0.176	70	2.47	0.9	1.98	35	77.2
6	0.212	80	2.82	1	2.21	40	88.2
7	0.247	90	3.17	2	4.41	45	99.2
8	0.282	100	3.53	3	6.62	50	110
9	0.317	150	5.29	4	8.82	55	121
10	0.353	200	7.05	5	11.0	60	132
12	0.423	250	8.82	6	13.2	65	143
14	0.494	300	10.6	7	15.4	70	154
16	0.564	350	12.3	8	17.6	80	176
18	0.635	400	14.1	9	19.8	90	198
20	0.705	450	15.9	10	22.1	100	221

build the Texan and Stereo FM Tuner
20 WATT IC STEREO AMPLIFIER



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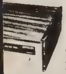

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THE LARGE BAND OF HAPPY CONSTRUCTORS!

STORISED MODULES
Power Suppliers - Amplifiers
RS (All single channel unless stated)

	£ p
9 volt 300 MW	1.75
9 volt 250 MW	2.70
9 volt 1 watt	3.10
9 volt 3 watt	3.95
12 volt 3 watt	4.10
12 volt 1½+1½ watt	5.95
12 volt 5 watt	5.10
24 volt 10 watt	4.95
28 volt 10 watt	4.95
45 volt 30 watt	9.95
30/35 volt 15 watt	5.45
45/50 volt 25 watt	6.95
24 volt 6 + 6	10.20

IERS WITH CONTROLS

12 volt 2½+2½ watts 8 ohms	8.25
Mains 7+7 watts 8 ohms	11.75
Mains 15 +15 watts 8 ohms	14.95
9 volt 1½+1½ watts 8 ohms	6.95
12 volt 3 + 3 watts 8 ohms	10.50

MODULES

1186 FM tuner (front end) with data	
Z O/P	4.85
M/Module	2.50
M/FM Module	4.50
M/FM Front End	4.85
1185 10.7 MHZ IF unit with data	4.50
mability FM tuner (front end)	
Z O/P	4.20

AM TUNERS AND DECODERS

2) 6 volt FM tuner	7.95
3) 12 volt version	7.95
coder for tu 3	7.95
ereo FM tuner	14.80
tuner	11.95
coder for above	7.95
IW-AM tuner	4.80
d FM tuner	13.95
decoder for above	7.50

PLIFIERS

reo 60 Preamplifier	6.75
Cart/Tape/Mic Inputs 9 volt	2.85
Stereo 3–30mV mag. cart. 9 volt	4.75
Stereo 3mV tape head 9 volt	4.95
Stereo 5–20mV Mag. cart. mains	5.95
Mono 3–250 mV Tape Cart Flay 9 volt	1.95

SUPPLIES MAINS INPUT
st cased)

9V 300 MA with ad'rs	2.25
500 MA	3.20
6/7½/9v. 400 MA stabilised	5.50
amp 3.30	3.30
amp.	3.30
V 1A 4.70	4.70
0.9A	7.80
0.4–1 amp	7.15
,9,12V, 1 amp stabilised	12.75
6/7½/9/12V ½ amp	4.20
5 VOLT 0–½A stabilised	17.50

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EMI SPEAKERS
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13 in × 8 in chassis speakers (Carr./packing 30p each or 50p pr.)

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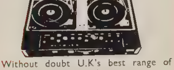

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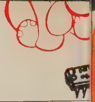

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COMMON MUSICAL TERMS I

The Table gives generally accepted definitions of common musical terms. The list will be completed in next month's Data Sheet.

Accelerando	accelerating
Adagio	slow
Affettuoso	tender
Agitato	hurried
Allegro	fast, brisk
Andante	flowing, even, moderately slow
Animato	animated
Appassionato	passionately
Aria	song, for one voice
Arpeggio	chord formed with notes sounded successively
Assai	very
Bolero	Spanish dance
Cadenza	a flourish
Cantabile	graceful, singable
Cantata	choral work
Canto	song
Canzone	song in two or more parts
Capriccio	free composition, quick
Chaconne	dance with slow movement
Chorale	slow, harmonised, choral work
Chromatic	using notes outside traditional keys
Coda	final passage
Coloratura	having florid vocal technique
Con	with
Con moto	with increased motion
Counterpoint	combining melodies
Crescendo	growing in force
Da ballo	dance style

Da capo	repeat from start
Da capo al fine	repeat to word 'fine'
Diatonic	music conforming to traditional keys
Diminuendo	decreasing
Doloroso	sadly
Entr'acte	interval or music between acts
Entree	introduction
Espressivo	with expression
Etude	study
Fandango	Spanish dance
Fantasia	fanciful composition
Forte (f)	loud
Fortissimo (ff)	very loud
Fortississimo (fff)	as loud as possible
Fugue	composition with contrapuntal melodies
Furioso	furiously
Galop	round dance
Gavotte	simple dance
Glissando	gliding, slurred
Grave	solemn, slow
Intermezzo	short intermediate movement
Largo	slow, broad
Langsam	slowly
Legato	smooth, with notes blending
Lento	slow
Maestoso	stately
Marcando	precise, with distinct notes
Mazurka	Polish dance

COMMON MUSICAL TERMS II

The Table gives generally accepted definitions of common musical terms, and completes the list started in Data Sheet No. 97.

Meno	less
Mezzo-forte (mf)	half loud
Mezzo-piano (mp)	half soft
Minuet	graceful slow dance
Moderato	in moderate time
Molto	much, extremely
Molto fortissimo (fff)	same as fortississimo
Molto pianissimo (ppp)	same as pianississimo
Mosso	moved
Motet	sacred cantata
Moto	motion
Non	not
Obbligato	musical accompaniment of independent importance
Pastorale	idyllic opera or cantata
Pianissimo (pp)	very soft
Pianississimo (ppp)	as soft as possible
Piano (p)	soft
Piu	more
Pizzicato	strings plucked
Plain-song	recitative choral music
Poco	little, small
Polka	Bohemian dance
Polonaise	Polish dance
Prelude	introductory movement, prefatory piece
Prestissimo	as quick as possible
Presto	quick, quicker than allegro
Prima	first
Prima-donna	leading female singer
Rallentando	with decreasing speed
Reprise	repeat of a passage
Requiem	Mass for the dead
Ritardando (rit.)	slower
Ritenuto (riten.)	held back
Rondeau	form of poem
Rondo	movement, musical setting for a rondeau
Rubato	in irregular rhythm
Saraband	slow Spanish dance
Scherzo	lively, playful passage
Scordato	out of tune
Scordatura	stringed instruments intentionally detuned
Secco	plain, unaccompanied
Sforzando (sfz)	sudden emphasis on chord or note
Sostenuto	sustained
Spirito	spirit, energy
Staccato	abrupt, disconnected
Stringendo	accelerating the tempo
Tarantella	Neapolitan dance
Tempo	time, rhythm
Tremolo	continual variation of amplitude
Troppo	too much
Tutti	all
Vibrato	continual variation of pitch
Vivace	lively, vivacious
Vivacissimo	very lively

BOOK 3: "Data and Circuits of Modern Receiving and Amplifying Valves" (1st supplement)
220 pages, 6in. x 9in., 267 illustrations.

This part contains the data and circuits of valves brought out in 1940 and 1941. It includes the so-called key-valves (all-glass series), the D series of receiving valves with 1.4V. filament and the 100 mA (U) series.

PRICE 12/- post free.

BOOK 3A: "Data and Circuits of Modern Receiving and Amplifying Valves" (2nd supplement)

No new types of valves were placed on the market during the enemy occupation of the Netherlands, although research was completed on the Rimlock series, later to be issued between 1945 and 1948, data and circuits for which are covered in this volume.

In preparation, available approximately September, 1952.

BOOK 4: "Application of the Electronic Valve in Radio Receivers and Amplifiers"
467 pages, 6in. x 9in., 256 illustrations.

Primarily for engineers and technicians engaged in the development of receivers and amplifiers, Books 4, 5 and 6 are of inestimable value to students of radio-technical engineering. The work has been divided into three separate parts, the present one covering R.F. and I.F. amplification, frequency changing, determination of the padding curve, interference and distortion due to bend in characteristics of receiving valves, and detection.

PRICE £1/10/0 post free.

BOOK 5: "Application of the Electronic Valve in Radio Receivers and Amplifiers"

Approximately equal in size to Book 4, this volume deals with A.F. amplification, output, inverse feedback and power supplies.

In preparation; available approximately June, 1952.

BOOK 6: "Application of the Electronic Valve in Radio Receivers and Amplifiers"

Similar in size to the two preceding volumes, Book 6 covers control (A.V.C., A.F.C.), contrast expansion and compression, stability and instability of circuits, feedback, interference phenomena, and calculations for receivers and amplifiers.

In preparation, available approximately September, 1952.

BOOK 7: "Transmitting Valves"
350 pages, 6in. x 9in., 285 illustrations.

Anyone actually working with transmitting valves or studying their applications requires a book such as this which deals thoroughly with the subject and contains concrete data derived from measurements.

In preparation; available approximately June, 1952.

The whole series is uniformly bound in blue linen with gold lettering, and protected by attractively printed dust-jackets.